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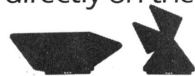
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AUGUST, 1982

VOL. 63, NO. 8

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ON THE COVER

The collage of images from TRON is adapted from a design by Michael Sterling. Jeff Bridges, David Warner, Bruce Boxleitner, Cindy Morgan and Barnard Hughes star in the adventure set in an electronic world where computer programs are characters and video games are mortal combat. Written and directed by Steven Lisberger the film features designs by Syd Mead, Peter Lloyd and Moebius.

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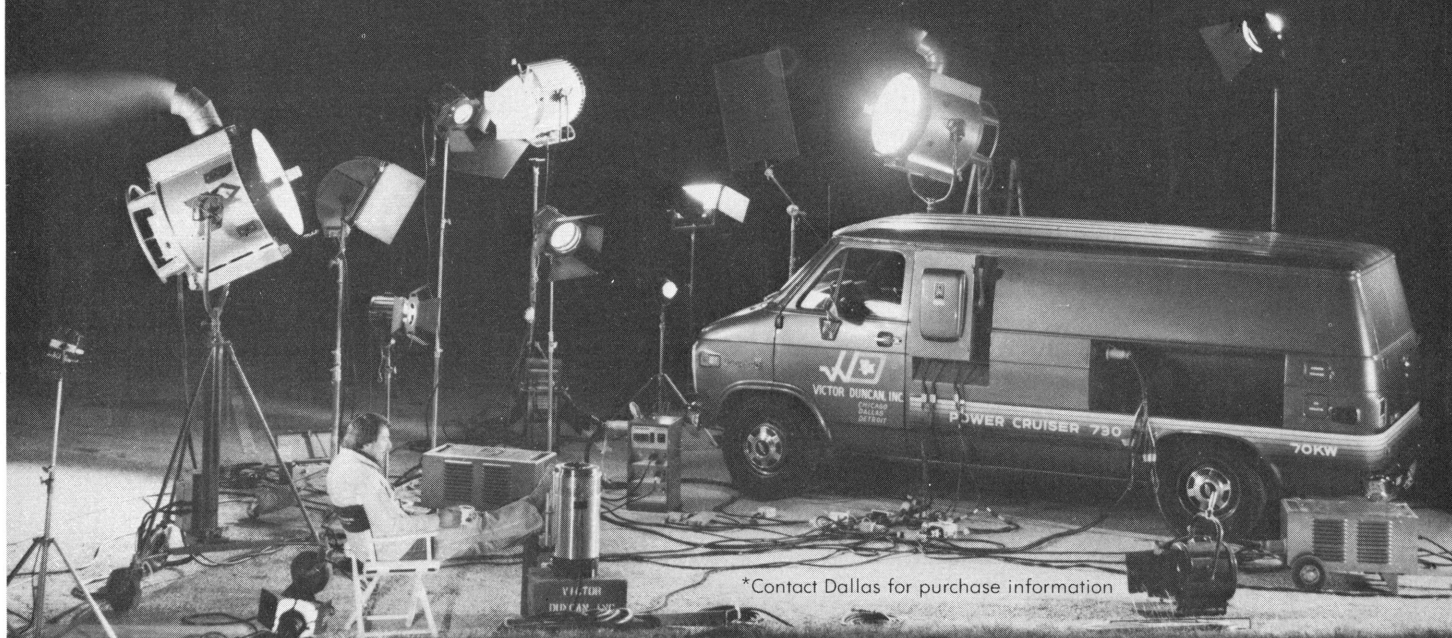
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FROM THE EDITOR

TRON is, I believe, the first movie to assume audience familiarity with computer technology. It is doing more than capitalizing on the fascination with video games. You don't have to know the difference between a bit and a byte to score well on Pac Man or Space Invaders, but you do have to know what a bit is to get the joke when a weird shaped object that can only say "yes" or "no" is introduced as a character in TRON. Admittedly much of the dialogue in TRON seems to be aimed at insuring the audience can understand the premise of the story, but nonetheless it is a movie in which computer programs are the principal characters and story points revolve around computer technology. When you meet an actuarial program who used to work for an insurance company and got satisfaction out of helping people plan for the future, you feel briefly as though you may be headed in the direction of "Saturday Night Live" but ultimately the movie hopes to connect with more serious emotional responses in the audience. Among the things I believe it seeks to tap is the anxiety that many people feel about computers and the possibility that technology has gotten out of control and is dominating our lives rather than serving our needs.

Computers can be very intimidating. They have a way of being viewed in extremes. Either they are seen as an incomprehensible and dehumanizing force which will automate the joy out of life, put masses of people out of work and foul up your bank statement; or they are seen as the greatest labor saving device since the invention of the lever, destined to liberate the human race from every conceivable form of drudgery and open up unimaginable vistas of creativity.

Shortly after Christmas my five-year-old son was learning how to use his new Children's Discovery System, an educational toy designed to look and work like a computer terminal. At one point when he figured out how to make it do something, he looked up at me and said, "I'm boss over this." I felt as though he had just experienced one of the most valuable lessons of his life, and I almost envied him because I had recently begun trying to understand

the computer we have in our office. Later when his grammar school sent home a letter explaining that the curriculum was being revised to make room for computer literacy courses for the fourth through the sixth grades, I was tempted to enroll.

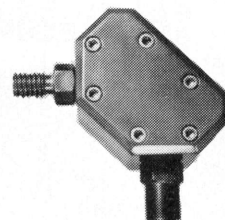
Part of what this issue of AMERICAN CINEMATOGRAPHER is about is an attempt to make computer technology a bit more accessible to filmmakers and to convey a sense of the marvelous potential computers can have as a tool in a creative process. Perhaps even more than video cameras and recorders, computers represent the electronic world into which all film production is headed. In fact one of the things that struck me as we were putting together this issue is that there are no "video" articles in it. When we began incorporating video production techniques into the magazine on a regular basis, it was assumed that about a third of the editorial content in each issue would be devoted to video. The problem is that it is difficult to distinguish between "video" and "film" production techniques because so many electronic tools associated with video are being applied to film. Most of the computer techniques described in this issue grew out of video technology.

The message of TRON is that computers are meant to serve individual users. Most of the programs want nothing more than to contact their users and to return to work for them. Similarly the message from people involved in computer research and development these days seems to be that computers are becoming increasingly "user oriented." The day is fast approaching when using a computer will be just as natural as driving a car or dialing a telephone. No doubt filmmaking in the future will be highly computerized, but this is not to say it will become dehumanized. In fact one of the reasons filmmakers are turning towards electronic technology is the hope that computers will make possible creative and humanistic films which would otherwise be too great a financial risk to produce.

RICHARD PATTERSON



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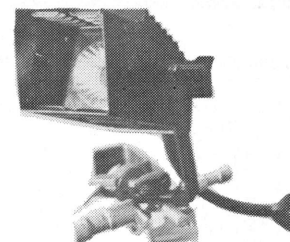
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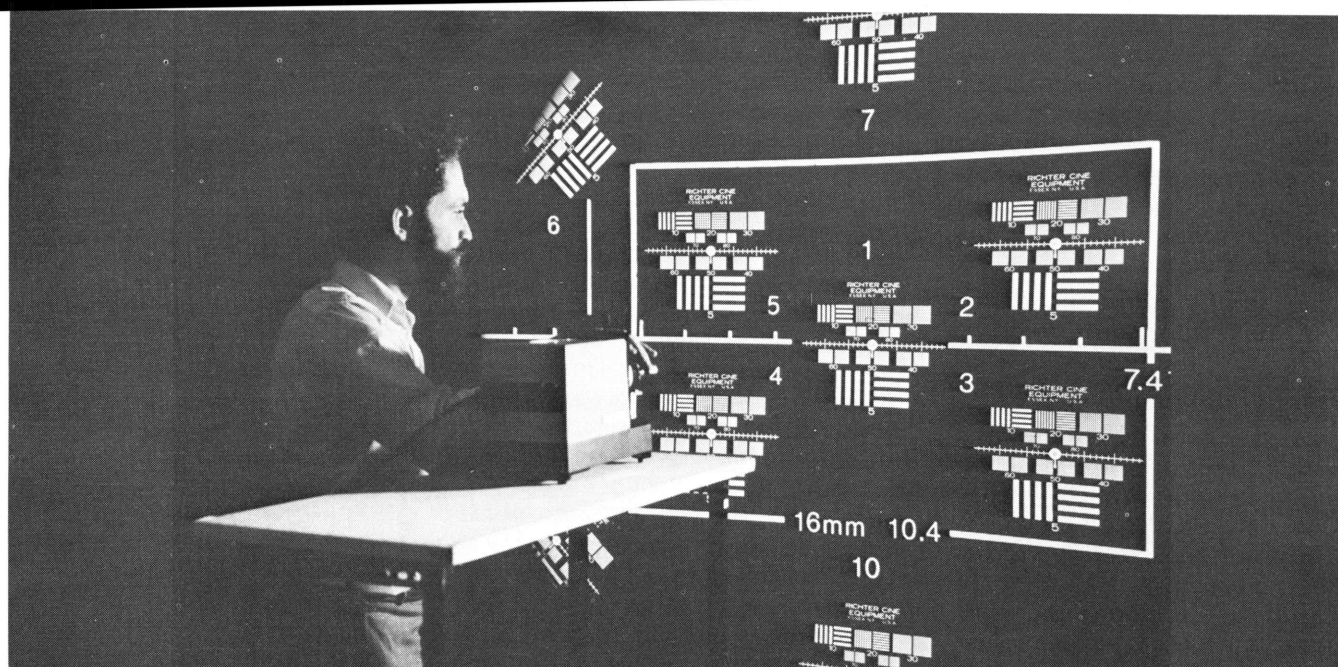
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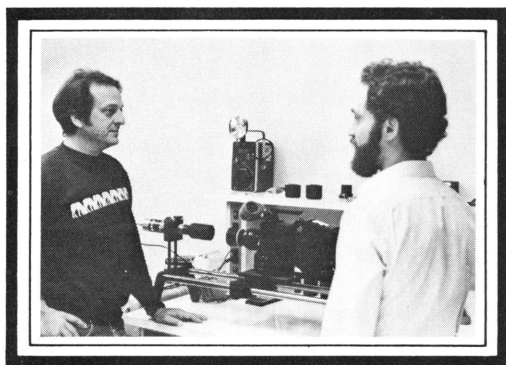
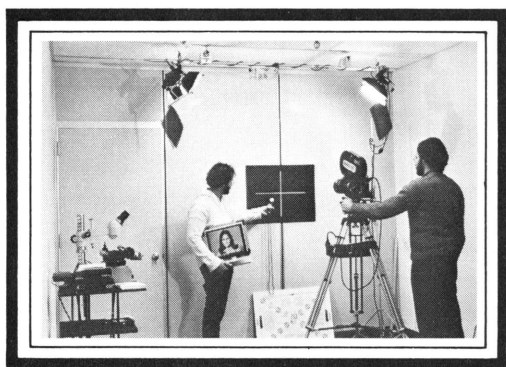
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LETTERS TO THE EDITOR

Communication Problems

I was surprised to read of the communications problems Howard Schwartz encountered in videotape production ("Single Camera Video Production: Part I Shooting 'Harper Valley P.T.A.' with the Panacam"). Although network news broadcasting is different from large-scale dramatic production, communications are quite similar. The usual system involves hard-wired intercommunications between control room personnel, camera operators, video controllers, tape operators and stage managers—using either push-to-talk microphones and speakers, or, for those actually on the set, earphones with attached microphones. On remote locations ABC News and ABC Sports have both had great success with helicopter pilot-type headsets which have high-noise-canceling earcups and condenser microphones.

Mr. Schwartz might want to look into the system we're using in our new Washington News Bureau: a low-power transmitter-receiver, jointly designed by ABC Engineering and Motorola, which provides mobile radio-communication with stage managers as they move about the 2800 square-foot main studio. It does not interfere with audio or video broadcasting signals originating in the room and interfaces with the master intercommunications system. A similar system is, I believe, available in Hollywood from Alan Gordon Enterprises.

John A. Armstrong
Senior Producer/Director
ABC News, Washington, D.C.

Communications systems can benefit film productions as well. Jordan Cronenweth reports great success with the use of headsets for his crew on BLADE-RUNNER. Rather than having to yell to an electrician to adjust a light, he could speak softly into a headset thereby making the set a much more pleasant place to work while at the same time improving communications.

Videotape Preservation

Richard Patterson's article "The Preservation of Color Film" contained an unjustifiable dismissal of videotape as an archival medium. Ampex developed videotape recording 25 years ago. Images recorded in the late 1950's show no signs of deterioration. The statement in the article that "the physical characteristics of the tape itself are such that the

image will deteriorate faster than a film image" is entirely untrue and completely ungrounded. Both tape and film must be stored in a cool-dry environment for maximum preservation. Tape, unlike film, need not be stored in the dark, so proper storage is actually easier to arrange for tape than for film.

Considering all the problems with film, your readers should certainly be informed that no deterioration of images has been detected on properly stored videotape. Readers who wish to know more about proper storage of videotape can see an article I have written, "Long Term Storage of Videotape," which will soon be published in the SMPTE Journal.

James Wheeler
Senior Engineer
Audio/Video Systems Division
Ampex, Redwood City, CA

We have referred Mr. Wheeler to Ralph Sargent's book Preserving the Moving Image and asked him to contribute an article to AMERICAN CINEMATOGRAPHER elaborating on the archival properties of videotape and making recommendations for storage of tape.

Motion Resolution

Congratulations for bringing the "film look" versus the "video look" dilemma out of the closet. However, in all your articles so far one major factor—perhaps the major factor—hasn't even been mentioned: frame per second rate. In terms of motion resolution, standard video is a 60 fps medium, not 30 fps, since each half-frame field contains its own motion sampling.

The following observations, all first-hand and however subjective, are offered:

1) 60 fps film looks like video. (Doug Trumbull's "Showscan" a 60 fps system using 70mm film.)

2) 30 fps video looks like film. (Ed Tannenbaum's "Discernability," which uses a real time video processor that repeats each video field twice, on display at San Francisco's Exploratorium.)

3) Video shot film-style still looks like video. (The recent NHK high definition television demo.)

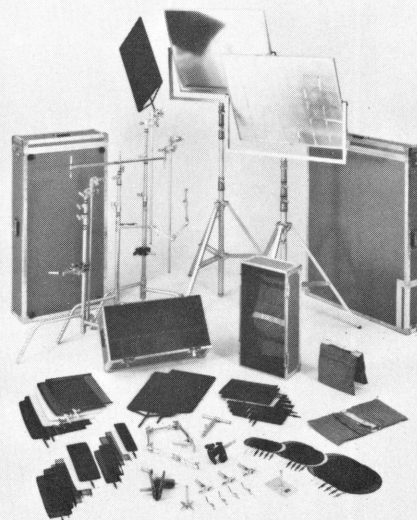
4) Film shot video-style still looks like film. ("Laverne and Shirley.")

Draw your own conclusions.

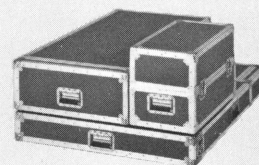
Michael Naimark
San Francisco, CA

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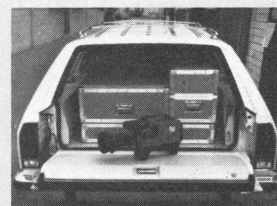
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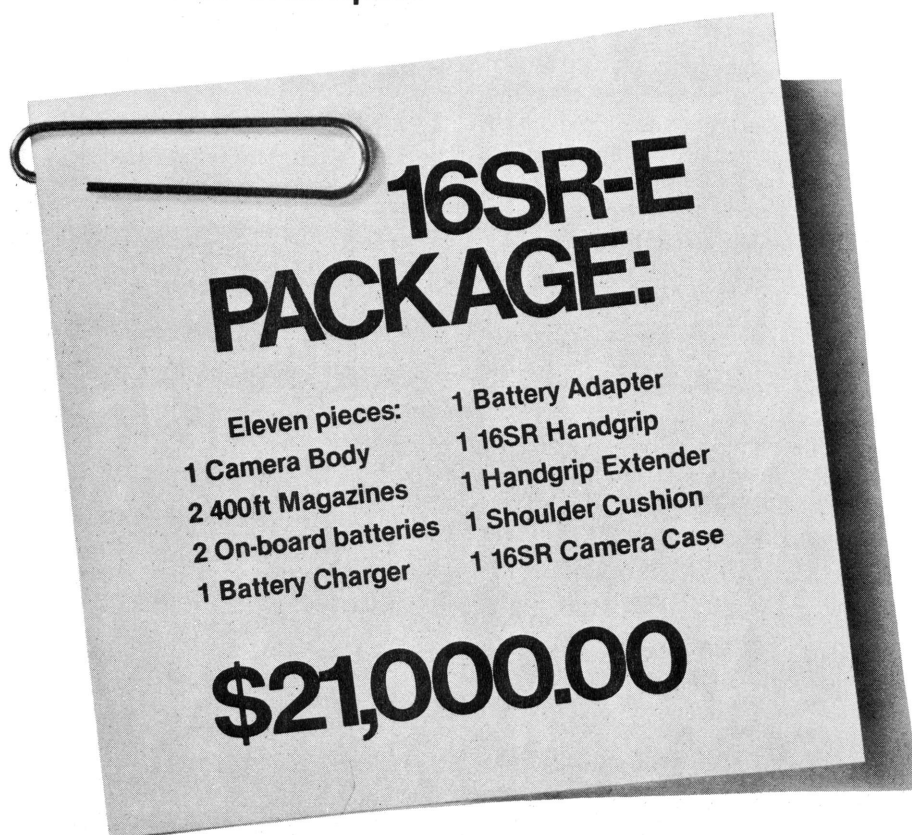
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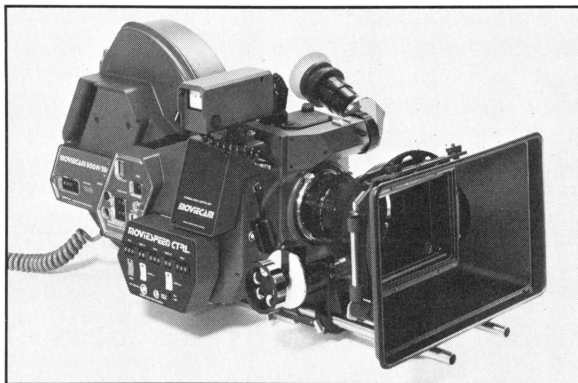
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THE BOOKSHELF

By GEORGE L. GEORGE

GENRES AND TECHNIQUES

A well-researched survey of animation between 1898 and 1928, **BEFORE MICKEY** by Donald Grafton chronicles the achievements of such European pioneers as Emile Cohl, Lotte Reiniger, Vladislav Starevitch, their American counterparts Otto Messmer, John R. Bray, not to forget Winsor McCay, Max Fleischer, the young Disney, and the Canadian Raoul Barré. Their combined contribution to the arts is spelled out in all its richness and diversity (The MIT Press \$25).

John Stanley's **CREATURE FEATURES MOVIE GUIDE** offers a comprehensive listing of close to 3000 horror, sci-fi and fantasy films, expertly reviewed and assessed by the late-night TV show host. The far-flung resources of the genre are paraded with conviction and humor in this encyclopedic directory (Creatures At Large, Box 687, Pacifica, CA 94044; \$8.95).

A standard classroom textbook, Louis Giannetti's **UNDERSTANDING MOVIES**, now in its 3rd revised edition, considers techniques and modes of film expression in a lucid appreciation of a complex medium that borrows freely from all other arts (Prentice-Hall \$13.95).

Stressing the importance of the sound element in film, Elisabeth Weis offers, in **THE SILENT SCREAM**, a pioneering study of language, sound effects and music in Hitchcock's movies as essential components of his artistic mastery (Fairleigh Dickinson U. Press \$19.50).

Perceptively edited by Stanley Hochman, **FROM QUASIMODO TO SCARLETT O'HARA** assembles some 200 film critiques published between 1920 and 1940 in the National Board of Review Magazine. This valuable anthology sheds an historic light on the original impact created by films now considered classics (Ungar \$24.95/\$12.95).

In **THE COMPLETE BOOK OF SCRIPTWRITING**, J. Michael Straczynski provides a comprehensive guide to dramatic scriptwriting in film, television, radio and the stage. His knowledgeable and practical advice covers the basic techniques of the craft, and

provides seasoned guidance to marketing the product (Writer's Digest Books \$14.95).

Now available in paperback, John Brady's *THE CRAFT OF THE SCREENWRITER* assembles the views of such renowned scenarists as Neil Simon, Paddy Chayefsky and Ernest Lehman (Touchstone/S&S \$8.25). Also Syd Field's *SCREENPLAY*, an expert step-by-step textbook for aspiring film scripters (Delacorte \$13.95, Delta \$6.95).

John Orlandello's *O'NEILL ON FILM* contrasts the playwrights' original dramas and their screen versions, probing the distinctive styles of both media and examining perceptively the reasons for their success or failure (Fairleigh Dickinson U. Press \$27.50).

THE DIRECTORIAL TOUCH

Experimental cinema is the domain par excellence where the "auteur" theory is most unlikely to be challenged. This notion, crediting the director as a film's true creator, is supported by Malcolm LeGrice's *ABSTRACT FILM AND BEYOND*, a lucid appraisal of avant-garde filmmakers' search for visual alternatives to time-and-space representations found in regular films (The MIT Press \$5.95).

Akira Kurosawa's profoundly introspective memoir, *SOMETHING LIKE AN AUTOBIOGRAPHY*, reveals the famous director's often intractable behavior, with deep roots in Japanese feudal tradition. The slow maturing of his technical and aesthetic concepts, his directorial methods, his battles with censorship and commercialism etch a unique individual both indebted to and at war with his cultural heritage (Knopf \$15).

An unusual biography by Italy's leading literary critic Enzo Siciliano, *PASOLINI* deals less with the director's complex and brilliant films than with his troubled personality—an intense mixture of feverish creativity, political infighting and unorthodox sexuality (Random House \$20). Published simultaneously, Pasolini's *POEMS* offer added insight into the inspiration and verbalizing of his art, a lyrical and angry outpouring filled with striking images and agonized sensitivity (Random House \$10.50/\$5.95).

Eisenstein's historic 1930 lecture at Hollywood's Academy of Motion Picture Arts and Sciences on the new

screen dimensions suggested by the then recently introduced wide film is published, together with other theoretical and critical pieces, in an invaluable collection, *FILM ESSAYS AND A LECTURE*. Knowledgeably edited by Jay Leyda, these thoughtful writings deal with Eisenstein's basic cinematic concepts, particularly "Problems of Composition." Required reading for all filmmakers (Princeton U. Press \$5.95).

THEIR NAMES IN LIGHTS

In *BOGART*, Terence Pettigrew surveys a career that started rather inauspiciously on Broadway before reaching its apex in Hollywood studios. A well-documented book, with excellent illustrations (Proteus \$8.95).

The nascent Hollywood film industry is the hectic framework for *MABEL*, Betty Harper Fussell's lively biography of the irrepressible Mabel Normand, who co-starred with Charlie Chaplin and Fatty Arbuckle in the early 1920s (Ticknor & Fields \$15.95).

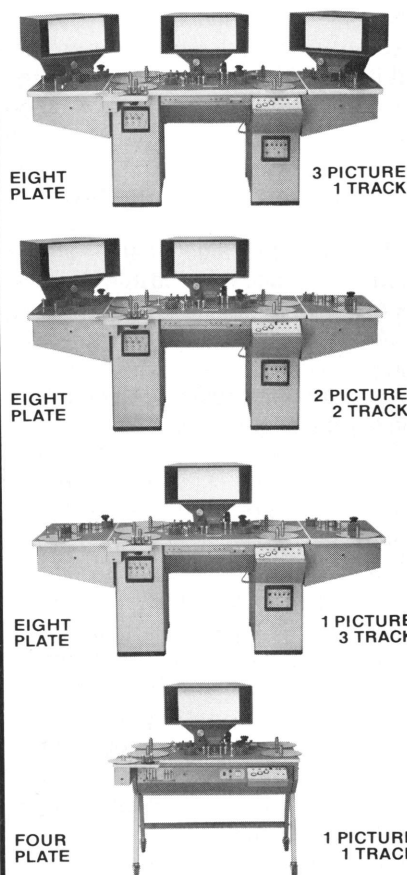
A balanced, thoughtful memoir, Gary Carey's *JUDY HOLLIDAY* relates the melancholy career of the comedienne, whose successful films (*Born Yesterday*, *The Bells are Ringing*) brought only temporary relief from personal unhappiness, political troubles and unremitting bad health (Seaview \$14.95).

William Hall's *RAISING CAINE*, the engaging biography of the versatile Michael Caine, tells of the actor's slow but steady rise from repertory and work as an extra to bit parts in film and television, before his lucky break in *Zulu* that catapulted him to stardom (Prentice-Hall \$15).

Capping a long and distinguished career in films, theater, opera, and politics, Helen Gahagan Douglas's posthumous autobiography, *A FULL LIFE*, offers an impressive record of professional achievements and dedication to public service. Talented, intelligent and an idealistic American, she evokes a rewarding existence set against the changing panorama of her country in transition (Doubleday \$19.95).

The tragic life of Frances Farmer—from stardom to mental institutions—is evoked by William Arnold in *SHADOW LAND*, a harrowing tale of the victim of wanton revenge and social irresponsibility (Berkeley \$2.75). ■

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TALKING TECHNICALLY

By DAVID W. SAMUELSON

ADJUSTABLE SHUTTERS

Last month I discussed the problem of using filmstocks which are so fast that it is not possible to stop down the lens aperture sufficiently to film in normal bright light conditions and suggested that one way to cope with the situation was to use a camera with an adjustable shutter.

I have often thought that of all the useful built-in accessories that a professional motion picture camera can have, an adjustable shutter must rate most highly.

There are three basic types of adjustable shutter systems viz:

The focal plane type as fitted to Panavision and Mitchell cameras which consists of a flat metal disc with a cut-away section which rotates just in front of the focal plane and has an adjustable segment which together control the amount of light reaching the film plane. These cameras have totally independent spinning mirrors which are used only to reflect light to the viewfinder once the focal plane shutter has closed. The great advantages of this arrangement are that the shutter disc can be set very close to the focal plane to give a sharp light cut-off and yet still leave room for a gelatine filter in a holder to be placed immediately in front of the film plane and that the adjustable segment can be adjusted while the camera is running.

The combined spinning mirror and light shutter type, as fitted to the Arriflex 35 II Box C model V and to Eclair Cameflex and 16NPR cameras. One unit acts as

both light shutter and reflex reflector with the adjustable shutter segment set close behind the mirror. With this system the shutter opening can only be adjusted while the camera is stationary and it is necessary to remove the lens from the lens port to see what the setting is.

The focal plane type often fitted to non-reflex cameras, usually high speed, which may either be adjustable to different openings (usually with a maximum of 120°) or may take interchangeable shutter blades of various openings, neither of which can be done while the camera is running.

Adjustable shutters are useful for the following reasons:

1. Reducing the amount of exposure to darken a scene or to increase the lens aperture.

2. Reducing the amount of exposure because the filmstock is too fast for the minimum lens aperture.

3. Reducing the amount of light reaching the film while at the same time maintaining a bright image in the camera viewfinder. This is particularly useful in conditions of bright ambient light when the pupils of the operator's eyes are dilated (stopped down) and he cannot see a darkened image through a reflex viewing system. It is also useful for improving the performance of a TV viewfinder system.

4. Reducing the exposure to reduce the depth of field.

5. Making exposure changes during a take without affecting the depth of field of or focal length of a camera lens.

6. Making it possible to select the cor-

rect exposure time for HMI lighting in any part of the world and when desirable still be able to select the maximum exposure of which the camera is capable.

7. Making it possible to film a practical TV set in the U.S. and other countries which have 60 Hz electricity supply which can only be filmed at 24 fps with a very precise 144° shutter opening, and still be able to use the camera with a larger shutter opening when required.

8. In instrumentation cinematography to ensure that the exposure period is sufficiently brief to arrest the photographed movement of a fast moving object.

In-shot exposure changes are most usually required when panning or tracking between darkly and brightly lit parts of a scene, or vice versa. In these days of super fast lenses and super fast filmstocks it is quite possible to take a shot of, say, a street scene lit only by normal street lighting and seen through a window and then pan to an interior scene "comfortably" lit for cinematography.

The in-shot exposure change can be made either by closing down the shutter opening during the pan or by adjusting the aperture of the lens, or both. Feature cameramen who most often use cameras which do have adjustable shutters which can be adjusted while the camera is running usually prefer to use the shutter option rather than the aperture one as it does not cause a noticeable change in the 'look' of the scene and because it is something they can conveniently do themselves while standing behind the camera operator.

For metal halide lighting in the United States and other countries with a reliable 60 Hz power supply and shooting at 24 frames per second, a wide shutter opening can be used if the 60 Hz and the 24 fps camera speed are both really accurate or are electrically locked together (Arri 35BL, III, 16SR or 16 BLEQ with an Arri External Sync Unit or Panavision Panaflex, Panastar or Super R 200 with a Panavision Line Synchroniser), but 144° is safer if the power supply or the camera speed are likely to fluctuate far from their optimums. In Europe, and other 50Hz areas, we have to have our fixed shutter opening cameras fitted with 172.8° shutters or we cannot shoot with MH lights unless at 25 fps, but even at 25 fps 180° is better for shooting a practical TV set.

EXPOSURE CONTROL BY SHUTTER ADJUSTMENT

Exposure	200° Camera	180° Camera	165° Camera
Full exposure	200°	180°	165°
Less 1/3 stops	160°	140°	130°
Less 2/3 stops	130°	110°	100°
Less 1 stop	100°	90°	80°
Less 1 1/3 stops	80°	70°	65°
Less 1 2/3 stops	60°	55°	50°
Less 2 stops	50°	45°	40°
Less 2 1/3 stops	40°	35°	30°
Less 3 stops		22°	20°
Less 4 stops		11°	10°

Shooting the rapids EFP-style with Steadicam...



Planning ahead with Steadicam, Cinema Products' Oscar-winning video/film camera stabilizing system, pays off in spades. Economically as well as artistically. A good example of such planning is a new sports series for cable TV, *"Outside The Arena,"* produced by Westwood Communications, Inc. (Eugene, Oregon).

The premise for the series is to take well-known sports figures out of their commonly-known element, and to feature them as they are engaged in various interesting activities. The pilot program involved videotaping a famous pro football player kyaking down the McKenzie River in Oregon.

To get the best footage from the camera raft (equipped with a Hitachi SK-91 camera and an HR-100 1-inch portable recorder), Steadicam was mounted on a specially built pole which was welded onto the framework of the raft.

"Even though the raft was forever being tossed every which way but the right direction, Steadicam came through with flying colors," says Steadicam operator Stephen W. Allen of Allen Production Services, Ltd. (Portland, Oregon). "In situations where I had to pay more attention to the water in front of the raft than to the monitor, Steadicam practically kept in frame by itself."

"Steadicam was an integral part of the planning for the production of this segment," says producer Bruce O'Neil.

"Future segments will no doubt place even greater demands on the Steadicam, due to the many and varied locations we plan to use for this series."

The results of the two-day Steadicam shoot on the McKenzie River were spectacular. Says director J. Clayton Lawson: "Steadicam enabled us to capture some of the most exciting moments ever shot on a white water river."

Steadicam, of course, is not restricted to "shooting rapids." On the contrary. It is a most versatile production tool which can be used effectively—even in "normal" shooting circumstances—in a thousand and one dramatic ways.



Steadicam operator Stephen Allen shooting with video camera and Steadicam on the McKenzie River in Oregon.

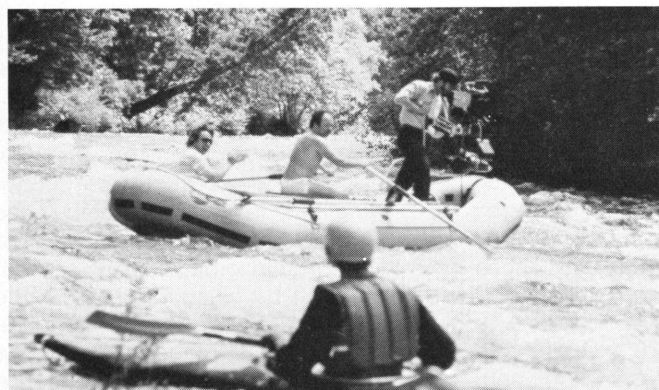
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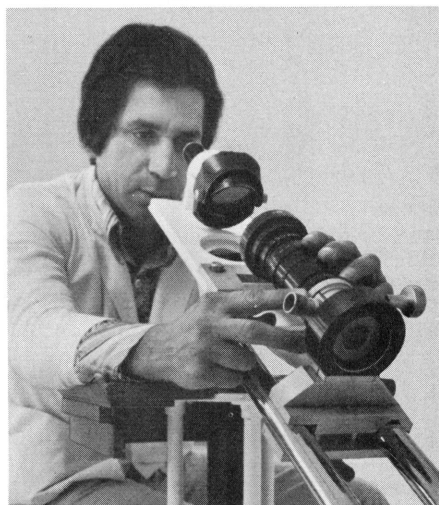
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In 60 Hz areas a very accurate 144° is essential for a practical TV set and if you need maximum exposure because there isn't too much light available to film by or you need maximum depth of field you need to be able to open the shutter to maximum, which may be 200° or more, depending on the make of camera.

Table 1 shows the effect of closing down the shutter from maximum, which does, of course, depend upon what the maximum opening is anyway. For instance a Panaflex which has maximum shutter opening of 200° needs only be closed down to 100° to reduce the exposure by half (1 stop), whereas a Mitchell S35 Mk II which has a maximum shutter opening of 170°, must come down to 85° to have the same effect.

The situation is not quite the same for the Arri B or C, (maximum shutter opening 165°) the Eclair CM3 (maximum shutter opening 200°) and some 16mm cameras because these cameras cannot be adjusted 'in-shot' so that the shutter needs only to be reset to give a particular exposure time.

Nothing is for nothing, of course, and the price in exposure terms of a camera with an adjustable shutter which exceeds 180° when fully open is that it cannot be fully closed down. Such cameras usually only close down to a minimum 40°, equivalent to 2½ stops of in-shot exposure control.

Yet another useful application for a adjustable shutter is in connection with stop-frame or time-lapse cinematography either to reduce exposure time or to correct exposure when the light level varies during a take. When regular motion picture cameras are used for single shot photography they do not accelerate quickly enough to give an exposure time as short (say 1/50 sec) as they would when running at normal speed (24/25 fps). The Panaflex camera, for instance, when used for single shot work (with the Panavision time lapse synchroniser accessory) runs at a speed equivalent to 4 fps irrespective of the frame rate, be it one frame per second or one frame per hour. By closing the shutter down to 40° it is possible to get an exposure period of 1/36 sec, fast enough to arrest most motion and give a reasonably sharp picture in most circumstances. If the take continues through the day, and even into the night, when the light is likely to change from bright to dull the shutter opening can be changed to give a range of 2½ stops of light control. It would not be possible, of course, to modify the lens aperture setting during such a take as the change in depth

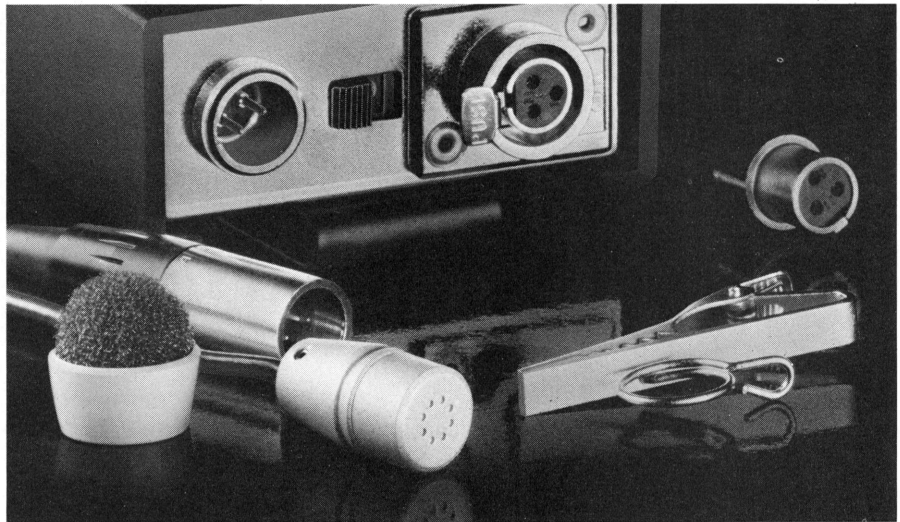
of field between individual frames and of the field of view with some zoom lenses would be very noticeable.

A couple of words of warning. Whenever picking up a camera with an adjustable shutter to use it for the first time and where the lens must be removed to see what the shutter opening actually is (Arri B or C, Eclair CM3 and NPR) do remove the lens to check that the last user was not using it with the shutter closed down and when using the Mitchell Mk II adjustable shutter facility don't close down more than 1 stop without testing that particular camera to check that the adjustable shutter blade does not 'float', giving uneven exposure between individual frames which appears as flicker on the screen.

For filming a practical TV picture in the U.S. or other 60 Hz countries there is a very useful Panavision accessory for Panaflex cameras called a 144° Shutter Vernier. This device fits onto the adjustable shutter block at the rear of the camera and makes it possible to make the necessary micro adjustment to the shutter to achieve the very precise 144° opening. To set the shutter for this purpose it is necessary to remove the film from the camera gate and replace the gate pressure plate with a special ground glass viewing device (called an Aperture Vernier TV Gauge) which makes it possible to view the TV set through the lens from the position of the film with the camera running. This is not the same as the normal reflex viewing, of course, because the shutter is in the taking position and not the film pull-down position. Looking through the camera in this manner it is possible to see the shutter as it would be photographed and to adjust the shutter opening until there is a maximum space or overlap between frames which would appear as a white or black line. In addition to the vernier device it is necessary to run the camera with the Panavision video film synchroniser unit which will electronically lock a Panaflex camera to a NTSC recorder and run it at 23.97 frames per second. If you don't do this and run on crystal control at 24 fps any line that does show will slip three frames in every 100 seconds.

In PAL countries, where we film practical TV screens at 25 fps one does not have to be precise about the shutter opening but it is necessary to place the TV bar line out of the picture area and this the Panavision video film unit, which must be plugged into both the Panaflex camera and the video recorder, will do automatically as soon as the film camera is running to speed. ■

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The CO94 also offers exceptional powering flexibility. It can be powered by a standard 9-volt radio-type battery. Or it can be phantom powered from a mixing board, recorder, or in-line supply. The

9-volt battery can even be used as a redundant power source to "back up" the phantom power. Plus, the CO94's advanced electronic design permits powering from virtually any DC power supply, (even an "el cheapo" battery eliminator) capable of delivering between 8 and 50 volts. The internal regulation and filtering will make the CO94's impedance converter swear it's being powered by an over-priced import supply.

These and many other performance features set the CO94 a giant step above the other miniatures you previously had to choose from. The CO94 is a versatile new kind of tool, and just one more reason why you should think of Electro-Voice as your microphone expert.



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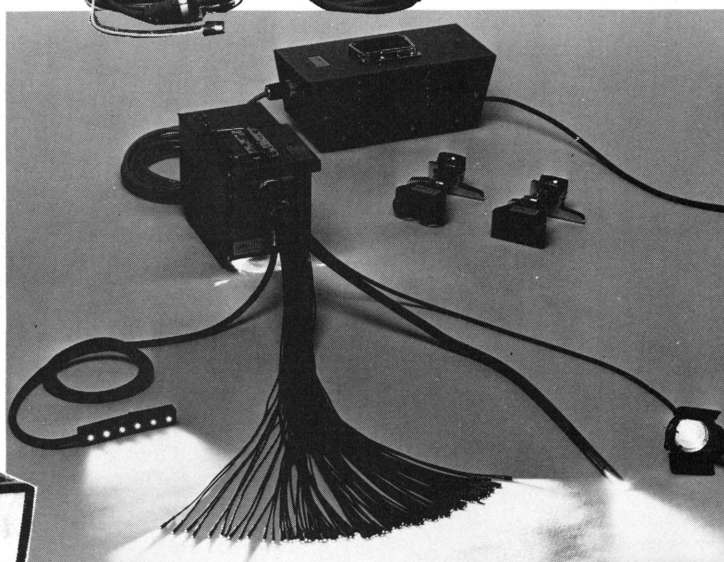
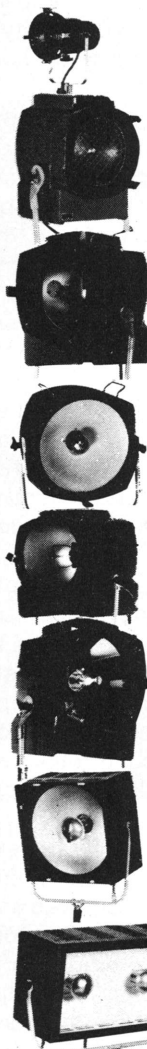
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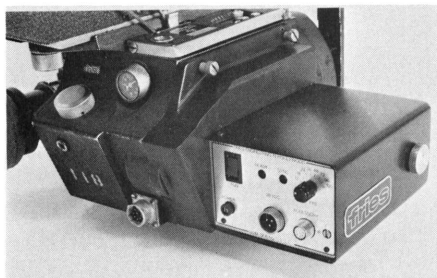
WHAT'S NEW

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MULTI-PURPOSE MOTOR FOR MITCHELL

Fries Engineering has just introduced a new multi-purpose motor for the Mitchell S35R (Mark II) camera. Now one motor does it all.

The model 120M2 is a small, modular unit integrating all of the features in one motor that now require several different motors. Features include speeds from single-frame through 120



fps high-speed, crystal control at 24 fps and 25 fps, forward and reverse operation, and automatic mirror positioning for viewing. An accessory connector provides remote control capability TV sync, strobe triggering, intervalometer, etc.

The motor operates from a standard 28 VDC battery or power supply. For further information contact Fries Engineering, 12032 Vose Street, North Hollywood, CA 91605. Telephone (213) 765-3600.

COMPUTERIZED BUDGET SYSTEM

InstaBid™, a computerized budgeting and accounting system designed to facilitate the development and actualization of both film and television estimates, has been introduced by The Production Source, Inc., a New York City-based production consulting firm and production firm.

InstaBid allows the user to compile data in a quick and orderly fashion for any type of production budget and provides a monitoring standard to evaluate expenses at all production stages.

InstaBid features convenient access of data in many forms—printed "hard copy," video monitor display, facsimile or verbally by telephone. It permits inputting and subsequent recall of "one-time-only" or of recurring data, such as

typical labor and material rates within a given set of production parameters.

The program is made up of schedules which can be displayed or printed out in either the AICP (Association of Independent Commercial Producers) form or in a PSI format, created to facilitate estimating for a variety of other types of production. The software can also be adapted to use a client's own format if desired.

InstaBid can be tied into a "general accounting package." Variances and other financial data could then be made available on a daily basis for both the producer and the financial department. The system can also be used for tracking sales taxes, payroll data, and for union contributions.

For more information contact The Production Source, Inc., 200 West 58th Street, New York, N.Y. 10019, (212) 765-4080.

COMPACT PERSONAL TRANSMITTER/RECEIVER

Audiotronics Corporation, North Hollywood, CA, announces a new low cost "hands-free" two way communications system for the person on the go. The Sportable 102 featherweight transceiver features a comfortable headband, and adjustable boom mike that lets two or more people communicate up to a range of 1/4 mile. As the user speaks, the voice automatically activates transmission, and then reverts to standby mode to receive messages, leaving the hands free.

The featherweight adjustable head-phone can be comfortably worn on either ear, leaving the other ear free to hear outside sounds, much safer than the standard headphone. The boom-mounted highly sensitive microphone



may be adjusted for optimum lip-to-mike placement, and a foam wind-screen shields out high winds or ambient noises. The power pack is about the size of a pack of cigarettes, and can be easily clipped to a belt or slipped into a pocket. A voice-activated sensitivity switch adjusts for all outside noise conditions and a continuously variable volume control allows the user to fine tune the earphone volume for an ideal personal listening level.

For further information contact Audiotronics, 7428 Bellaire Ave., North Hollywood, CA 91605, (213) 765-2645.

U/F-35 35MM EDITING CONSOLE

Cinema Products Corporation announces the availability of the new U/F-35 Upright/Flatbed 35mm film editing console. Based on the same design concept as the U/F-16, the new U/F-35 editing console incorporates the best features of *upright*, synchronizer-style editing machines, with those of modern *flatbed* editing tables.

The Cinema Products unique upright/flatbed design permits complete interchangeability between the 16mm and the 35mm formats by simply lifting off the existing tower assembly on the editing console and replacing it with the alternate format tower assembly. (Both the 16mm and the 35mm tower assemblies are available as separate units.)

The basic U/F design employs three sets of terraced feed and take-up plat-ers and three vertically-mounted sprocket wheel assemblies, to accommodate one picture and two sound tracks.

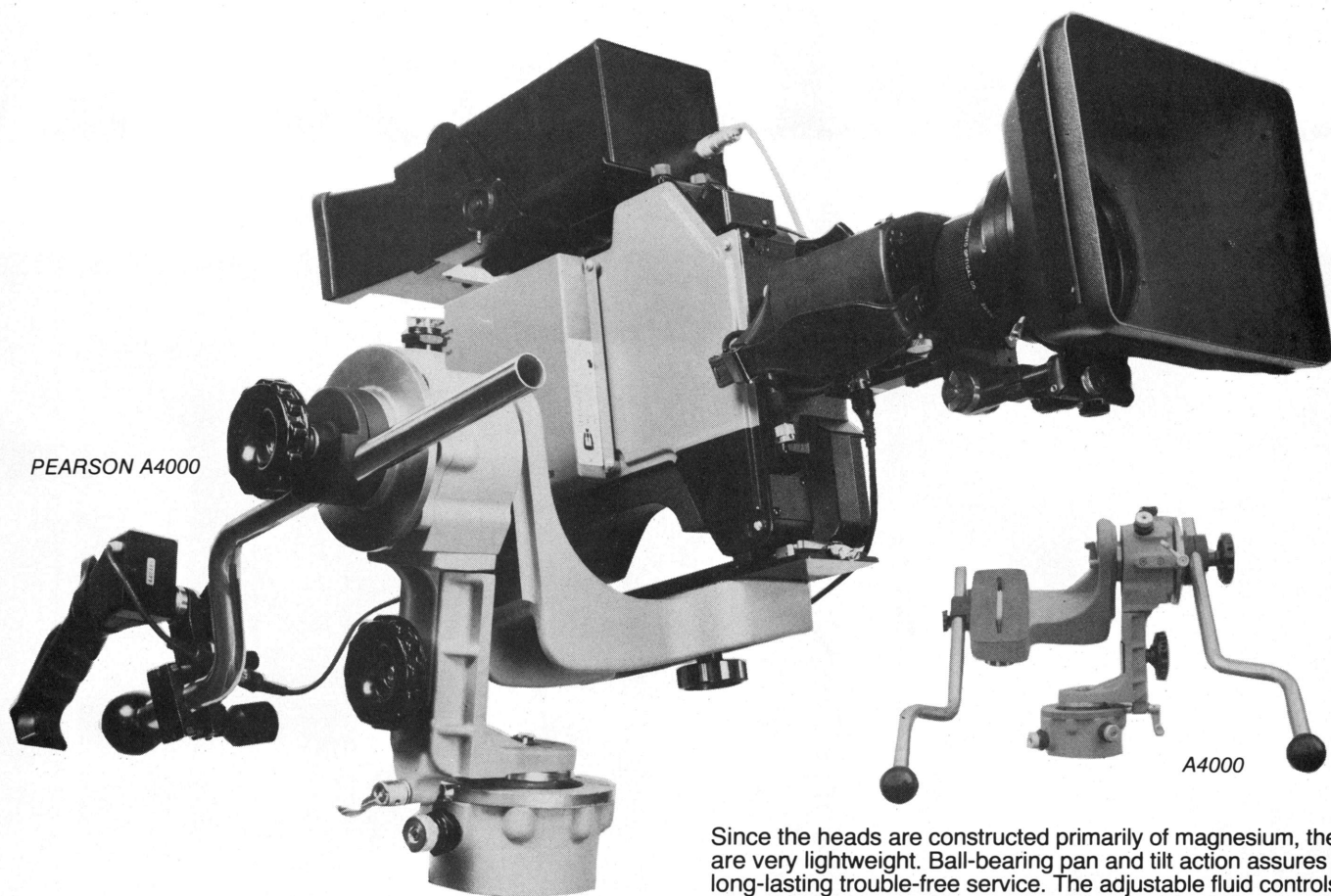
The U/F-35 features crystal-controlled sync-sound speeds of 24/25 fps, with variable speed control from 0.5 to 120 fps forward and reverse; push-button on/off in sync mode stops machine right on desired frame; slide attenuators for each sound track and master gain; rotating switches for high/low equalization.

The display head tower features a unique hollow polygon prism system, placed away from all heat sources and ambient room contaminants, for continuous flickerless projection on a bright viewing screen. Digital LED display indicates elapsed time in hours, minutes, seconds, film frames, and feet or decimeters.

For more information, contact Cinema Products Corporation, 2037 Granville Ave., Los Angeles, CA 90025. (213) 478-0711 or (213) 477-1971. ■

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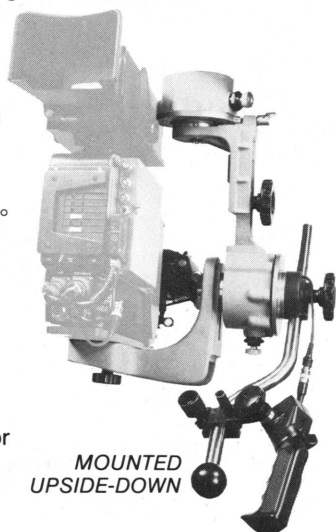
The Pearson fluid head provides "springless counterbalance" for a wide variety of film and video cameras.

Springless counterbalance is possible since the camera mounting platform is designed below the fulcrum point of the head. The camera mounting yoke is adjustable to match the camera's center-of-gravity height.

Counterbalance of any camera is of ultimate importance to every cameraman. It allows you to tilt the camera to any position and release the handle *without it moving!*

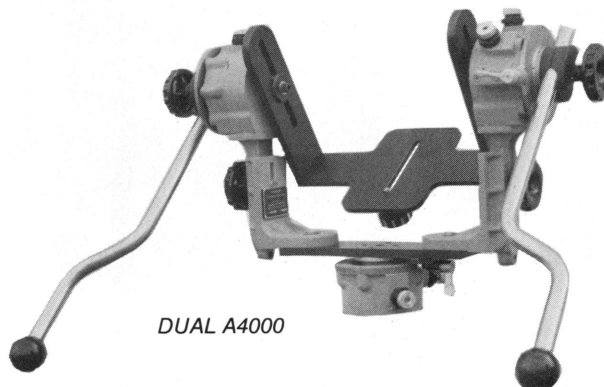
The adjustable fluid tension allows fingertip control of 360° pans and tilts. Unlike any other fluid camera head, the Pearson A4000 is capable of making a full 360° tilt with many models of cameras.

The unique design of the Pearson head allows it to be mounted upside down, providing a low optical axis for ground level and table top filming.



MOUNTED
UPSIDE-DOWN

Since the heads are constructed primarily of magnesium, they are very lightweight. Ball-bearing pan and tilt action assures long-lasting trouble-free service. The adjustable fluid controls allow the cameraman to vary the torque required for the smoothest pans and tilts. And there are two models. The A4000 is designed for small to medium size cameras, whereas the Dual A4000 is designed for larger cameras and video cameras with handle-mounted zoom and focus controls.



DUAL A4000

Just think of those times your tired arms tried to hold the camera in an awkward tilt position and still get a steady shot. Now, forget them. The Pearson fluid head achieves perfect counterbalance and . . . *with no springs attached!* Call or write for details.

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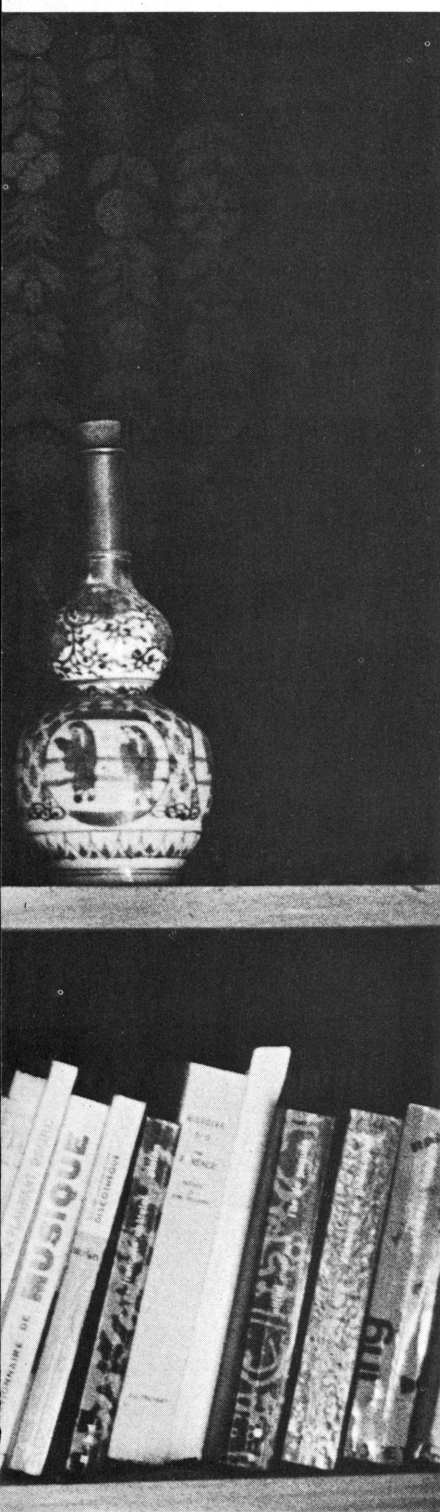
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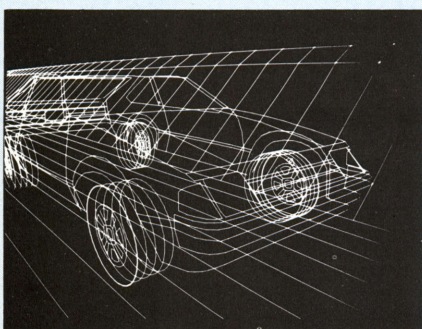
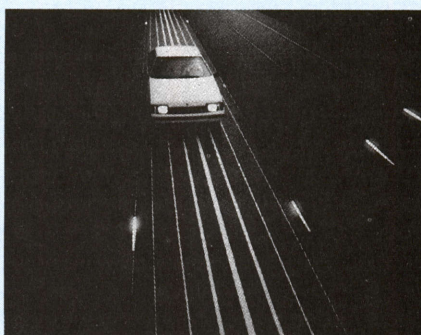
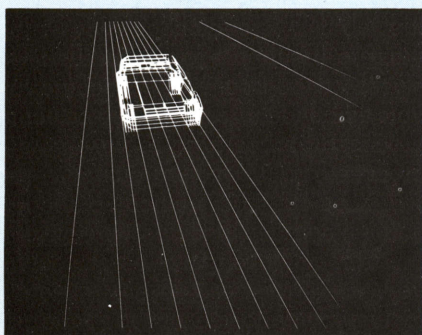
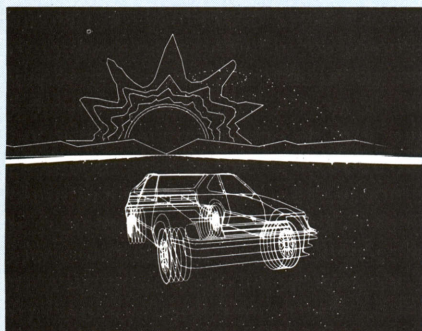
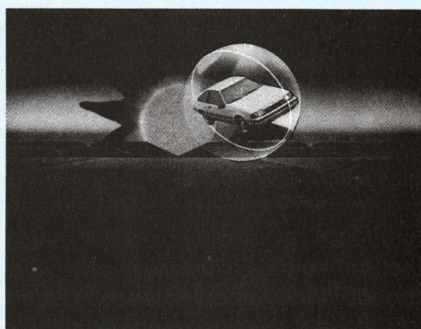
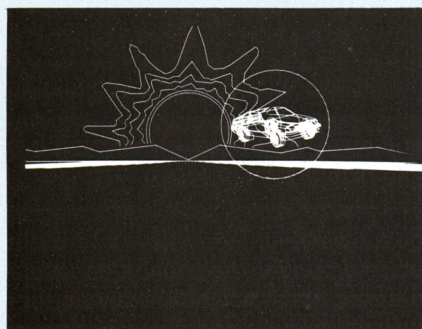
Equipped with the compatible circuit installed by Aaton, the Nagra you have now can handle both. The time address recorded on the quarter inch pilot track will be laid onto the edge track of the full coat every second during transfer.

When it comes to editing, the time information printed right onto the fullcoat backing will be matched with ease to the clear time addresses exposed onto the film edge by Aaton 16 and 35 mm cameras.

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COMPUTER MODELS: *The Ultimate Storyboard*



Picture a director walking into a large shooting stage to brief a crew about the first shot they will do. He says, "Lay 14' 3" of dolly track starting here and 3° off magnetic north. We'll start with the zoom at 28mm and dolly to this point in 5.1 seconds. Keep going and when you get to this point you should be zoomed out to 20mm and I want to pan 23° to the right." A skeptical key grip questions how he can be so sure about the shot before the set has been completed, and the director replies, "Don't worry about it. The computer's got it all figured out." He turns to the camera operator and hands him some film clips. "Here's some clips for frame 1, frame 80, frame 124, and the end composition."

This may sound a bit surreal, but it is essentially what happened when Robert Abel shot a Toyota commercial. The crew knew that all the shots had been worked out on Abel's computer, but nonetheless it still amazed them to see a composition on the set match up perfectly with a film clip everytime they moved to a new position.

In some instances on other commercials he has been able to computerize the camera and the dolly so that the move happens automatically. He still has to make sure the actors hit their marks, but he knows the camera will be there on cue.

The computer system Abel uses to plan these shoots is a modification of a computer graphics system developed by Evans and Sutherland in their work on flight simulators. It is a vector graphics system which displays line renderings of shots based on data about the sets, props and actors which have been entered into the computer. For the Toyota commercial illustrated here a drawing of the side and front view of the car was entered via a "digitizing table" enabling the computer to construct a three dimensional mathematical model of the car which could then be rendered on the screen from any point of view and modified ac-

Vector graphics animatic and corresponding frames from the finished commercial in which live action photography of the car was composited with a computer generated background.

cording to the field of view for a given camera lens. Plans for the set were also digitized and then manipulated in order to determine how much to force the perspective in constructing the sets.

Once the data base has been created for all the elements in the shots, the computer can then play out line renderings of shots in which the objects move at a specified rate and the camera moves and zooms. These shots can be viewed on the monitor in real time or they can be photographed onto black-and-white film to be shown to a client as a pencil test or "animatic" for the spot. The animatic can include every angle and every move. One client wanted an animatic which could be used to test the commercial with viewers and then was so pleased with the reaction they got that they canceled their order for the actual production and aired the animatic as a final commercial.

Abel uses the system for several reasons. First of all it enables him to be absolutely certain that the client understands what they are going to shoot before going into production. It is one thing to describe shots verbally or even to draw storyboards and quite another to actually show someone a line rendering of the entire commercial with every camera angle and move accurately represented.

Secondly the computer enables Abel to budget accurately so that he can bid competitively for a job. He can know exactly how much of the set is going to be seen from what kind of angle so he does not have to spend unnecessary money overbuilding the sets. He can know exactly what kinds of setups will be involved in the shoot and plan the shooting schedule more accurately. He can more accurately determine the amount of stage space and the crew size he will actually need to get the shots he will use.

Finally the computer enables him to experiment with the visuals in the storyboarding stage to a degree that would otherwise be impossible. No matter how well one can picture a shot in his head, there is still a difference when you see it play on a screen. With his computer graphics system Abel can work out exactly what he sees in his head and then try all the variations that occur to him in the process. Once the data base has been created, it is possible to execute 6 or 8 completely

different versions of a commercial in one day. The computer animatic enables him to evaluate editing and pacing as well as the composition of individual shots.

Although Abel's system has been used primarily for commercials and special effects sequences, it could be applied to the production of features. Abel insists that it would be possible to construct a computer model of an entire feature for \$50,000. As he points out, if the computer model enabled a production to save 10 shooting days, this could represent a savings of \$500,000 without even taking into consideration savings on set construction. He can envision a situation in which all of the key production personnel sit down with the writer and director and producer to view a computer model of an entire feature and evaluate not only the pacing and overall structure of the film but also the costs of every individual scene. Since the computer could know exactly what would be involved in shooting each sequence it could estimate the production costs for various approaches to a scene. For example if the director was able to see that a certain scene would play better in close ups, the computer would be able to indicate the savings in set construction and production time created by eliminating the wider angles from the schedule. Or if a sequence seemed to be too costly, the computer model could be used to explore less expensive alternatives until one was found which satisfied the needs of the story and was affordable. The computer model might also convince everyone that the expensive scene was essential to the success of the movie and some other solution would have to be found.

Anything that is going to be shot on a stage with sets could be previewed with absolute precision via the computer because the blueprints for the sets could be used to create the data base in the computer. Obviously films to be shot on location would be a bit trickier, but for one commercial Abel used blueprints of an actual building to create a data base which enabled him to match a helicopter shot of the building with a computer generated shot which moved inside the building. Needless to say, the computer can not simulate an actor's performance, but it can provide stand-ins for planning the visuals.

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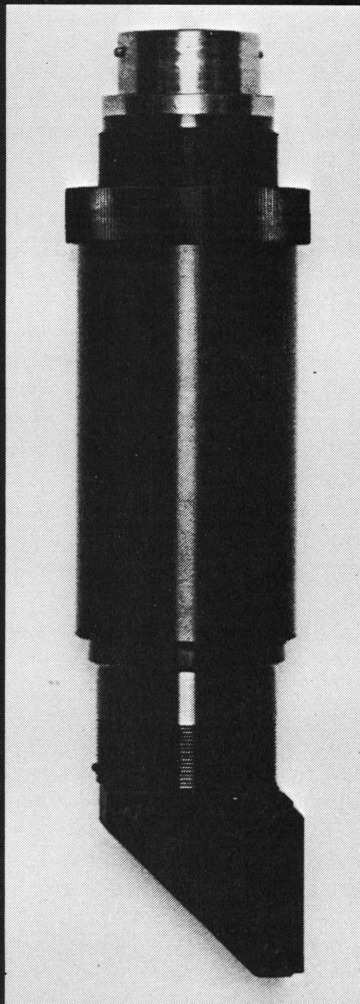
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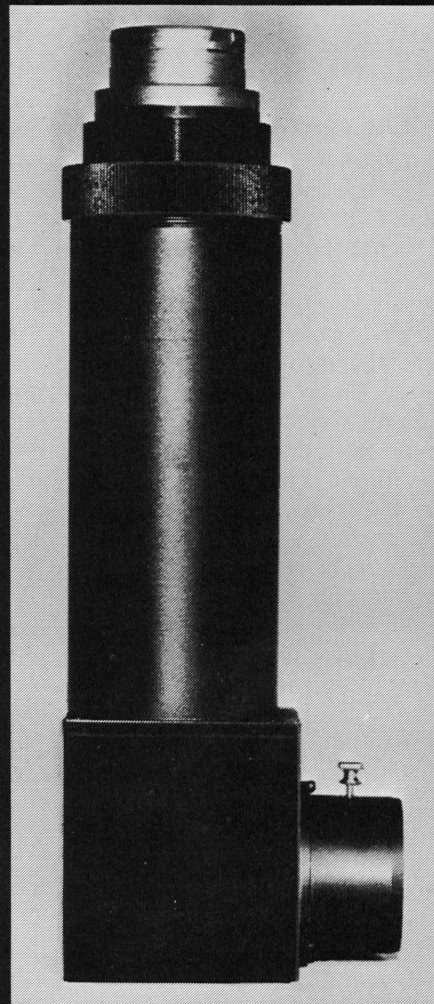
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TIME CODE ON FILM:

Kodak's Transparent Magnetic Coating For Film

Kodak recently announced a development which may have a revolutionary impact on the use of motion picture film. They have devised a method whereby it is possible to coat the base of the film with a transparent magnetic coating which can be used for recording time code. What this means is that motion picture film can be "frame addressable" by computer, i.e. a computer can read transport device with absolute frame accuracy.

The implications of this development are far reaching and may have a significant impact on the current trend towards the use of videotape as a production medium instead of film. Kodak has not actually started manufacturing film with the magnetic coating on it, but they have demonstrated that they can do it if there is a sufficient demand for it. They are now hoping that equipment manufacturers will design the components necessary to take advantage of the technique.

The coating consists of iron oxide particles (gamma ferric oxide) dispersed in a cellulose acetate similar to the base of the film. It is less than 8 microns (or .2 mils) thick and is applied over the entire surface of the base side of the film during the manufacturing process. Because the coating is a cellulose acetate there would be no problem with chipping or cracking or peeling off the base of the film. The iron oxide particles themselves are 1/2 micron long and 1/10th micron wide and there are approximately 9 billion of them per square inch. Since the coating is on the base side of the film, it has no effect whatsoever on the exposure of the film. It does add transmission density of less than 0.15 to the film however which must be compensated for in printing. In essence the coating acts as a very light neutral density filter in printing or projecting.

The coating is essentially the same as the iron oxide coating used in magnetic recording tape except that it is in a transparent binder and the density of

the particles is low enough to make the oxide transparent. It responds to magnetic fields in the same way as conventional magnetic tape but because of its much lower density its output is approximately 56 db lower than magnetic tape. This means that it can record digital data or an audio signal with a fidelity comparable to that of a telephone. It is not designed to record a sound track, but it could conceivably be used for voice cues of some sort. Anything recorded on it can be erased just like a recording on magnetic tape.

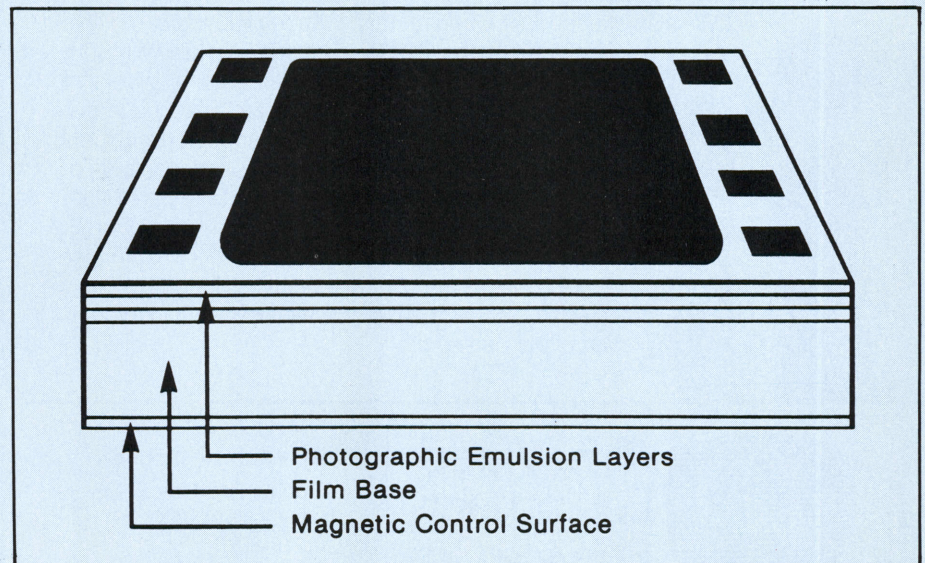
There are two ways in which data could be recorded on the track. With a 75-mil record/playback head in contact with the coating, it can record more than 266 bits of data per inch or at least 100 bits per frame on a track outside the picture area. This is well in excess of the amount of data required for an 8 digit SMPTE time code number for each frame of either 16mm or 35mm film. Secondly it would be possible to record and play back a similar amount of data without having the head touch the surface if the entire width of the film were used for recording.

NO CLAPSTICK

The ability to record time code on

film as it is being exposed in the camera would, first of all, eliminate the need for clapsticks. If a time code generator were feeding time code to the camera and the audio recorder simultaneously, there would be a running sync reference throughout every scene. It would also be possible to record a scene and take number and even a code identifying the camera or recorder used along with the time code because the number of bits available per frame would so far exceed the number required for time code. The script supervisor or assistant cameraman could slate each scene by entering the scene and take number via a small keyboard of some sort before each take, and no film would have to be wasted shooting a slate with clapsticks.

Circled takes could be specified in terms of time code numbers or scene and take numbers which could be read automatically by a printer at the lab. The printer would simply wind down the uncut roll of negative until it came to the scene to be printed and then print that scene or even a specific portion of that scene. The same procedure could be followed in making a videotape transfer from the negative and also in making transfers from the



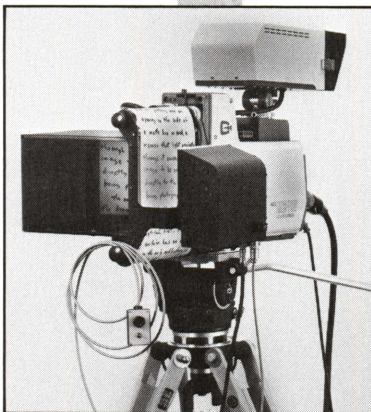
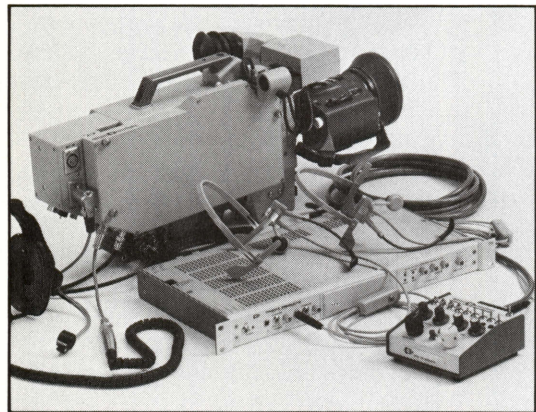
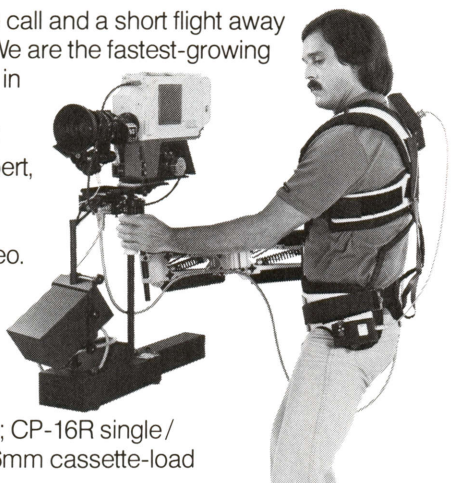
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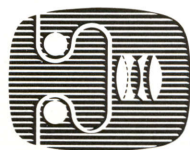
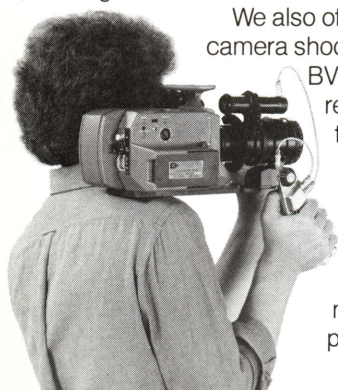
For example: the Oscar-winning Steadicam® camera stabilizing system; Camraprompter; U/F-16 and U/F-35 film editing consoles; Co-Ax digital remote control systems for ENG/EFV cameras (from distances up to 5000 feet!); CP-16R single/double system sound cameras; GSMO 16mm cassette-load



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production sound rolls.

If time code is recorded onto the workprint to correspond with the time code on the negative, it would be possible to sync up an audio playback machine and a projector or editing console in such a way that the audio machine would search out the proper time code on the sound track to keep it in sync at all times. It could be possible to view sync dailies using the production sound rolls, and the necessity of synchronizing up dailies could be totally eliminated. All of the logging could also be done by computer.

Once a workprint was edited, the time code would provide the means of automatically logging the cuts and ultimately for automatically conforming the negative to the workprint. Probably with time code on the negative, the negative would never need to be cut. A printer could be designed to make an internegative or an answer print by printing only the appropriate portions of the negative on the appropriate frames of the new rawstock. All of the procedures used in the auto-assembly of an edited master videotape could be adapted for use with film.

If a production is shot on film and edited on videotape, time code on the negative would greatly facilitate conforming the film to the edited tape by means of the edit decision list from the video editing system.

Optical printer operations could be almost totally computerized with time code on the negative. Every laboratory or post-production function which currently requires reference to code numbers or key numbers could be computerized. Once workprint is edited, a second track in continuous time could be recorded on it for use in scoring sound effects cutting, and mixing. Multi-track audio machines could be synchronized with every kind of film transport system for editing or re-recording sound in sync with picture.

Release prints could make use of time code for such things as projection changeover, inspection and inventory, and even captioning or sub-titling.

One of the beauties of the new Kodak technology is that it can be adapted piecemeal. It does not require a wholesale conversion of existing equipment and is in fact totally compatible with existing equipment. Many existing cameras, projectors, editing consoles, printers etc. could be modified to take advantage of time code on film, and film with time code on it could still be used with conventional equipment.

Computer Research and Development at LUCASFILM

Housed in a new building in Marin County adjacent to the facilities of Industrial Light and Magic is a division of George Lucas's company called Sprocket Systems. Sprocket Systems consists of the post-production facilities for Lucasfilm and the Computer Development Group staffed with about 35 people under the direction of Ed Catmull. The computer group is doing research and development in four areas related to filmmaking; but unlike the work being done at Zoetrope Studios, their research is not tied to ongoing production. Instead, research projects are developed into reliable production tools and only then are adopted by the team working on a new film.

Only one of the areas has reached a stage of development where it has been applied to the productions of *REVENGE OF THE JEDI*, the next *STAR WARS* episode. Another branch of the group has done some work for one outside production; but basically the computer research group is engaged in fundamental research designed to create production tools of the future rather than to solve the immediate problems of a current production.

The goal of all this work is to maximize the creative control of a filmmaker over the most complex production processes, to enable all of the logistics to serve the vision of the guiding hand behind the film. The computer research group grew out of Lucas's feeling that much of the equipment and techniques used in conventional filmmaking is significantly behind the times. His conclusion was that the best way to bring about changes in the film industry would be to develop the new tools himself. The intention is to use these tools first for his own productions and then to make them available to the rest of the industry by licensing someone else to manufacture and market them.

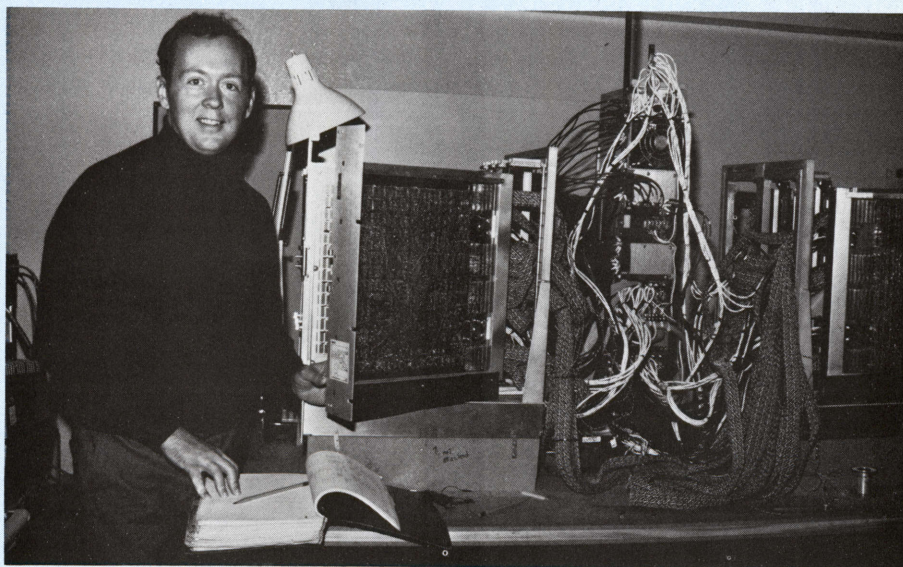
The four areas of development are 1) a database system designed for film production, 2) a digital sound processor, 3) computer graphics and 4) video

editing. The database system developed under the direction of Malcolm Blanchard is actually being used to support the special effects work being done at I.L.M. for *REVENGE OF THE JEDI* and other outside productions. The system is essentially a way of putting into the computer all of the paperwork associated with filmmaking — camera reports, storyboards, count sheets, etc. While the system has so far been applied primarily to special effects work, it can obviously be developed to encompass all of the organizational work involved in planning and producing a movie. This aspect of the computer work at Sprocket Systems is a relatively straightforward application of information processing techniques to the unique requirements of a film production.

The digital sound project is headed by Andy Moor, a former co-director of the computer music group at Stanford. The goal of the project is to develop a real time digital sound editing and mixing system for film sound tracks. Although there are digital recorders and storage systems, and even a system for simple editing of digital sound, there is

no commercially available equipment for manipulating and mixing sound digitally in real time. The digital sound group at Sprocket Systems has built a general purpose machine which is currently being programmed to record, process and mix sound digitally. The processor is designed to have a variable sampling rate which can be set to whatever the needs of a specific job are. The intention is to work primarily at the industry standard of 48 KHz, although it is possible that the work done for film tracks intended to be transferred to an optical track would only require a sampling rate of 35 KHz. The processor will be able to perform a variety of unusual types of processing in addition to the normal re-equalizing, filtering and mixing processes. Emphasis at first will be on the application to film sound work — such things as adding location presence to sound recorded in a studio or doing weird special effects on a voice — but ultimately the machine can have a wide variety of applications in music and recording for all purposes. The sound is stored on disks which hold up to 50 minutes of sound depending on the sampling rate.

Andy Moor, head of the digital audio project, with one component of the group's real-time digital sound processor.



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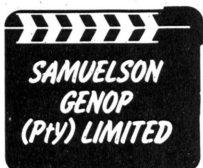
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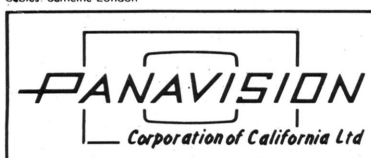


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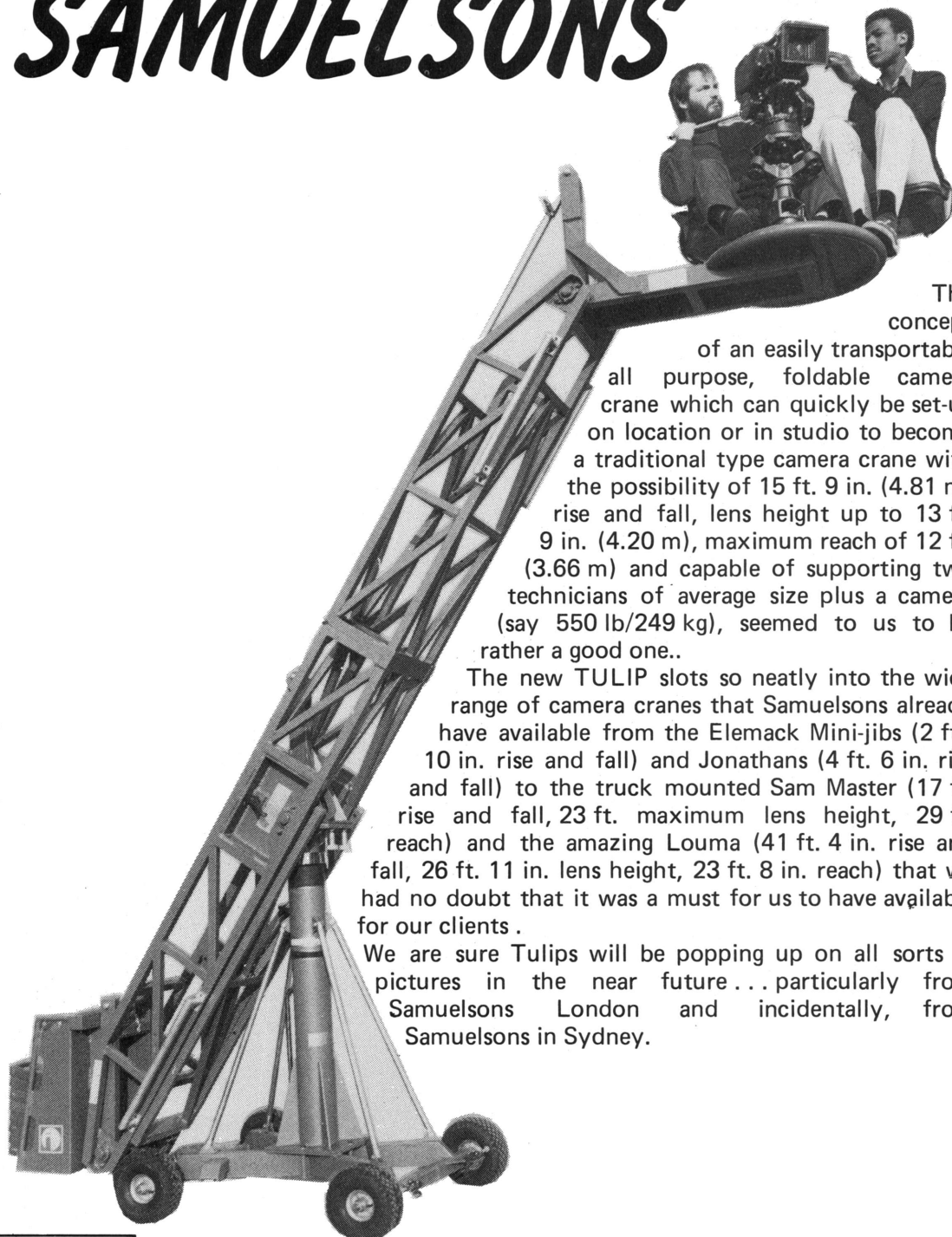


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We are sure Tulips will be popping up on all sorts of pictures in the near future... particularly from Samuelsons London and incidentally, from Samuelsons in Sydney.

COMPUTER ASSISTED FILMMAKING

The computer graphics project headed by Alvy Ray Smith has as its goal the generation of high resolution realistic scenes to be composited with filmed action by means of a digital printer. The group is exploring the feasibility of using computer graphics to create the sort of images that are now created with models or matte paintings. There is also the possibility of generating entire films in the computer, but the first applications of the computer graphics project to production will be in the area of special effects for live action films. The system was in fact used to create one flying shot for *STAR TREK II*, which will be described in detail in a future issue.

The approach used in the computer graphics system at Sprocket Systems is comparable to the approach used at Triple I for the work done on *TRON*, except that, as Smith describes it, "It tends to be very general, very slow and very rich in the final result — as rich as human imagination permits." The paint program for the system has a palette of 16 million colors as compared to the normal limitation of 256 colors for any given scene in a computer image. This is due to the fact that the computer graphics system at Sprocket Systems uses a 32 bit byte with 8 bits assigned to the red, green, and blue signals respectively. Although current research is being done with a system having the resolution of a standard television image, the goal of the research is to develop a high resolution comparable to that of 35mm film. The research group has not yet decided how many scan lines would be required to achieve this and can only say that they expect it to be somewhere between 500 and 8,000.

In the meantime the group is developing programs designed to facilitate the creation of realistic scenes. One of the members of the group, Loren Carpenter, has perfected a technique which makes it possible to construct a data base in the computer for a landscape. He has entered information describing a hypothetical piece of terrain about 50 miles square and then created a movie in which the camera flies through the landscape by entering instructions designating the camera position and field of view relative to the overall landscape for each frame. Another bit of mathematics developed by the group creates an image of a

plant which "grows" in an organic manner. Emphasis is also given to insuring that the images generated by the computer do not have the jagged edges so often associated with computer imagery and to creating realistic textures for the surfaces of the objects.

In addition to the color graphics system the research group has a black-and-white line drawing system which is capable of real time animation. Smith estimates that it will be five or ten years before full color computer animation can be done in real time, but the black-and-white system which works in terms of lines rather than points of color can be used to do animation studies in real time and is particularly useful for doing tests of three dimensional animation.

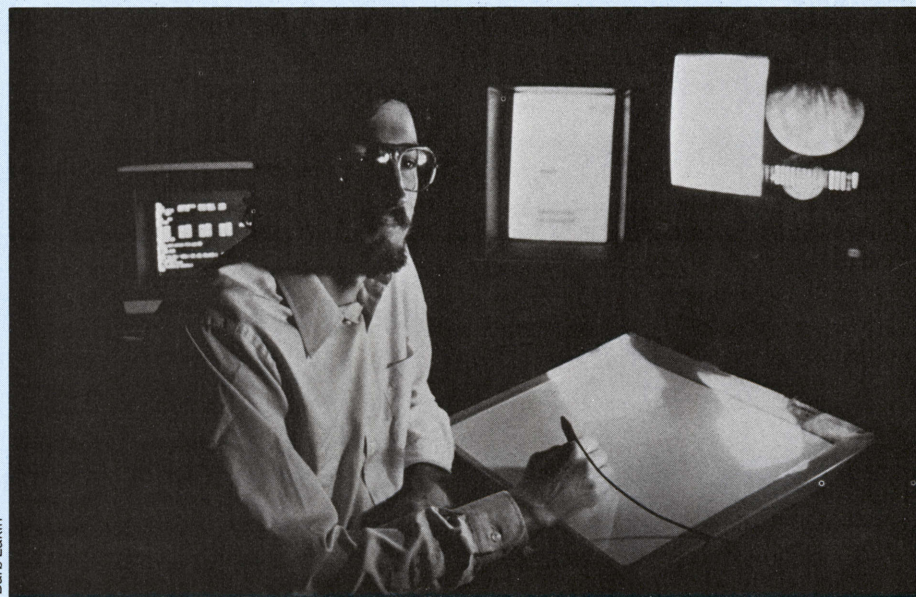
The research in the development of new editing tools will take the form of a computer-assisted editing system combining the speed and efficiency of video editing with the flexibility of film editing. The group, headed by Ralph Guggenheim, expects to solve some of the traditional problems facing film editors working in video: 1) how to facilitate re-editing of sequences recorded in video and, 2) how to "human engineer" the editor's interaction with the computer and video equipment. Their approach is to build a general-purpose editing system, applicable to film or video production. For productions where film is the final product, the computer is programmed to produce a frame accurate cut list from the video workprint. It's also designed with the

expectation that videodiscs will soon play a significant role in film and video editing. With their ability to find any frame of material from a 30 minute disc in a matter of seconds, videodisc editing could be accomplished without having to record each shot on a master videotape. With several videodisc players on line (a system may use as many as 8 or 10) it is possible to preview extended sequences without having to record them, since the edited sequence is created by switching back and forth between playback machines.

The group has already acquired and assembled most of the video hardware, under the direction of video engineer Clark Higgins. This includes a Videola film transfer system, a variety of videotape and videodisc recorders, and a small video switcher. They have already produced the software for a 2-machine prototype editor which they have since discarded in order to develop the full-scale system, capable of controlling videodisc and videotape. They have rejected the notion of using a keyboard as a user interface and are considering joysticks, touch screens and other control devices.

One interesting offshoot of this work is a games project which is designing interactive entertainment devices built around the videodisc. The two projects are not altogether unrelated because as one of the members of the research group put it, "Editing is really an interactive game, when you come right down to it."

Tom Porter, a member of the Lucasfilm computer graphics team with a computer-controlled pen/tablet that gives artists the ability to paint pictures directly on a television screen.



Barb Lakin

Gary Coleman starrer, "The Kid With The 200 I.Q."

I.Q. PRODUCTIONS

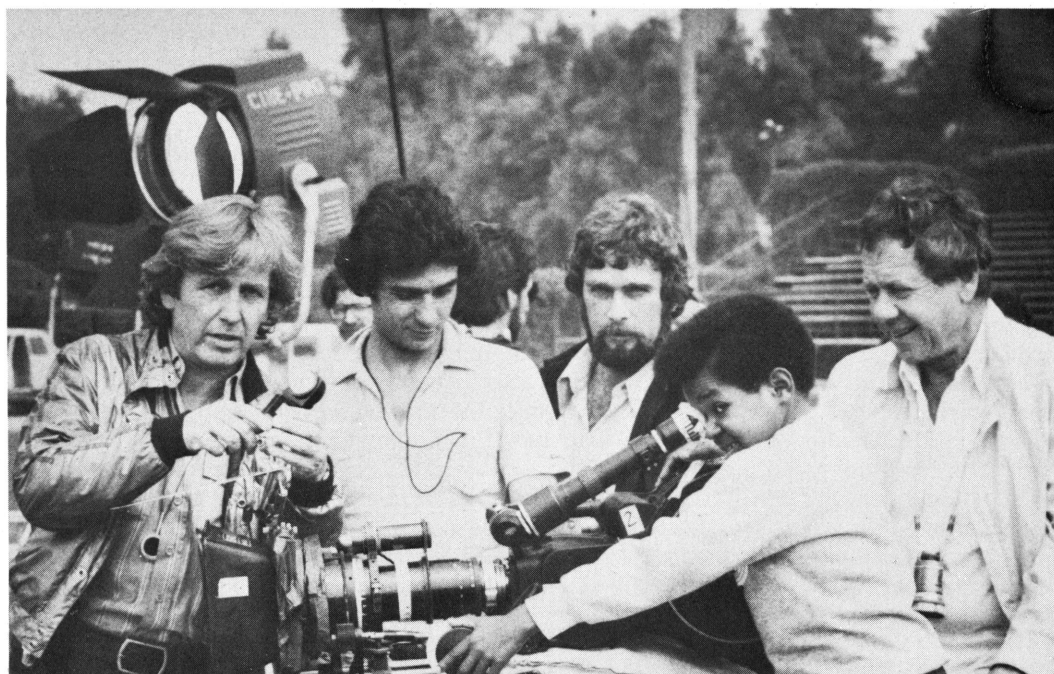
Producer: Jim Begg

Assoc. Producer/Prod. Mgr.:
Jim Ragan

Director: Leslie Martinson

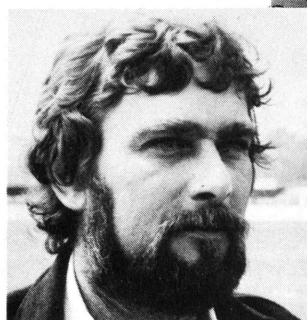
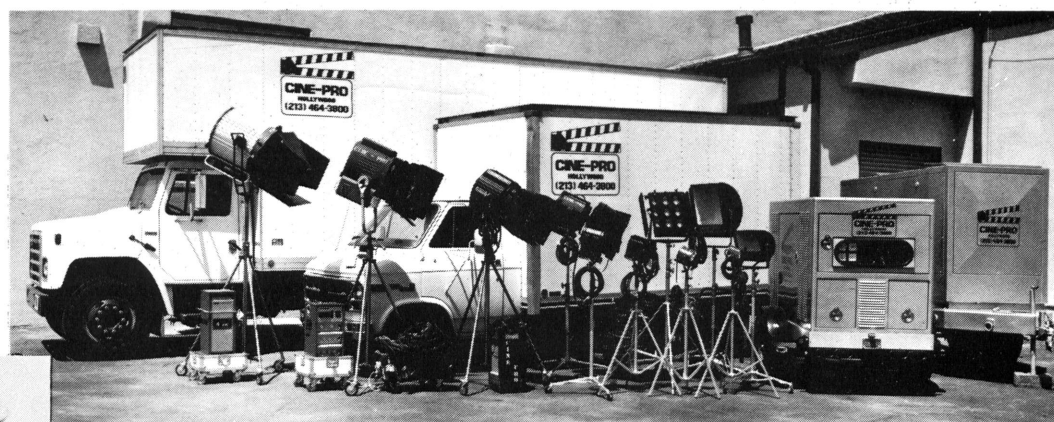
Director of Photography:
Gary Graver

Gaffer: Jono Kouzouyan



L. to R.: Gary Graver, Jono Kouzouyan, Jim Ragan, Gary Coleman, Leslie Martinson.

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JIM RAGAN, Associate Producer and Production Manager, is widely regarded as one of the most competent and fastest-rising young production executives of the motion picture industry. He says, "I deal with Cine-Pro whenever I have the choice, because it's my responsibility to do the most cost-efficient job possible on each production. This picture is a good example: going right to the bot-

tom line, Cine-Pro saved us a bundle of money. Our *total* rental cost from Cine-Pro for camera (the new Arri 35BL-3)...electric...grip...generator...trucks...the whole thing...came to *less than the cost of the camera package alone* on a previous picture, where an executive insisted on using a different supplier. Just one thing more; for sure, we got a *lot* faster and more dependable service from Cine-Pro, from start to finish...and, believe me, that counts at the bottom line, too."



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Coppola's ELECTRONIC CINEMA SYSTEM

In the midst of shooting *THE OUTSIDERS* on location in Tulsa recently Francis Ford Coppola took time out to discuss his electronic cinema system. He felt that the press had largely misunderstood what he was trying to do with the system he developed during the production of *ONE FROM THE HEART*, and he was concerned to emphasize that the point of the system is increased production efficiency. Ultimately the goal is to enable the production of more varied or personal films by reducing the time and money and risk involved in making them. While he acknowledges that the system did not necessarily accomplish this on *ONE FROM THE HEART* (just as the development of any prototype is rarely cost-effective in the short term), he points out that *THE OUTSIDERS* is being produced with a 7 week shooting schedule and is scheduled for release within six months of the initial commitment to finance it. On *HAMMETT* Coppola credits his system with enabling 75% of the film to be completely rewritten and then shot in 21 days for \$2 million while the other 25% of the film he figures cost \$6 million. Moreover he plans to begin shooting a second picture with a similar schedule only a few weeks after the completion of photography on *THE OUTSIDERS*.

The objective is to increase the efficiency without compromising the quality. Coppola sees the economic realities of the film business limiting the films being made to certain tried and true formulas, and he believes that the application of electronic technology to production is the best way to relieve this pressure on the creative community. He also sincerely believes that the system he is working towards will be universally adapted as the way to make films once the increased efficiency and productivity become apparent to studio executives—and to other directors who are looking for a way to reduce the hassles of making a film so that they can concentrate on the creative aspect of it. Also it is an objective of the system that the control method be as personal and

non-technical as possible so that it is more like an instrument than a machine.

Coppola's production system is constantly evolving as new approaches are conceived and new hardware becomes available. In terms of hardware there are two or three new ingredients in the system as it was being used for *THE OUTSIDERS*. There is first of all a highly sophisticated information processing system, currently the Xerox Star, which will ultimately provide the nexus for all phases of the production. Secondly there is a touch control video editing system adapted from a system developed by Control Data.

Another piece of hardware on a different level of importance is a miniature TV receiver which was adapted for microwave so that it could function as a viewfinder for the director displaying the video tape from the camera without tying the director down. Coppola was able to move around observing a scene either by eye or by means of the finder which he held in one hand. He also wore

a set of earphones so that he could hear the dialogue as it was being recorded.

The key to Coppola's vision of an electronic production system, however, is not individual pieces of hardware but the concepts behind his use of them, and the best way to understand Coppola's use of the hardware on his current production is to see it in the perspective of the ultimate production system he is developing.

Coppola views his system as a radical departure from the traditional organization of a production into pre-production, production and post-production phases. To some extent the point of his system is to enable all three phases of production to progress simultaneously. This is accomplished by improved communication among personnel via the information processing system and increased speed of manipulation of image and sound via electronic technology. It is also facilitated by a working method in which the film is evolved from a script through several intermediate steps prior

Coppola discusses a scene in *THE OUTSIDERS* with C. Thomas Howell, Matt Dillon and Ralph Macchio on location in Tulsa. Rather than making the creative process more abstract and impersonal as some might fear, Coppola's electronic cinema system permits him to concentrate more of his energy and attention on the human and creative process of making a film.



Once more National Geographic's TV specials make history.

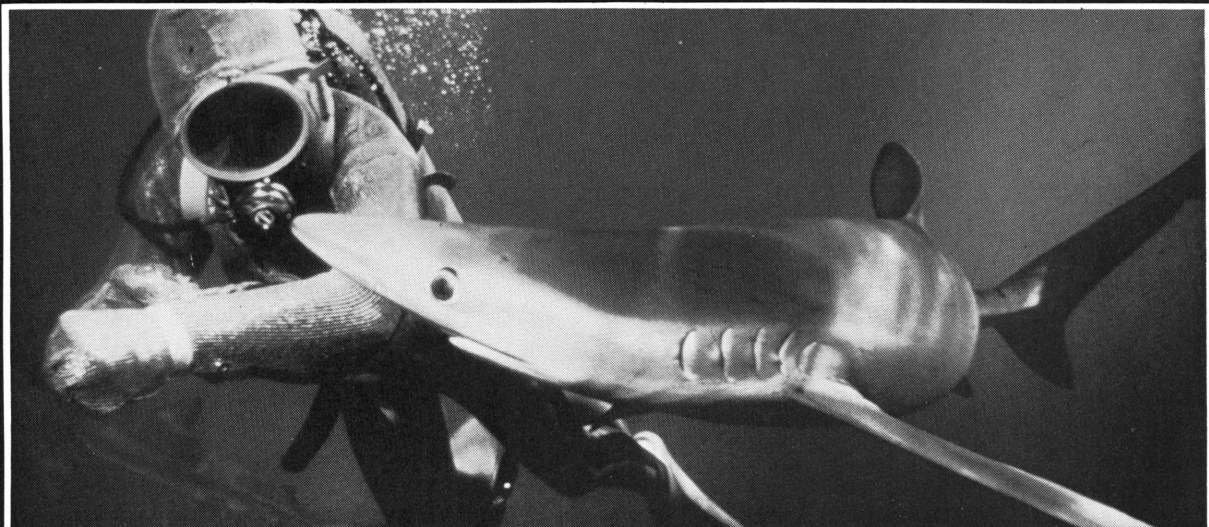


photo Ron and Valerie Taylor

"Sharks"—Bert Van Munster, Director of Photography

The ratings speak for themselves. *Sharks*. *Polar Bears*. *Egypt*. *The Thames*. All four of these National Geographic specials attracted phenomenal audiences, and *Sharks* set a record by drawing the largest audience of any program in the history of PBS.

"Polar Bears"—Jim Lipscomb, Director of Photography



photo David Hiser

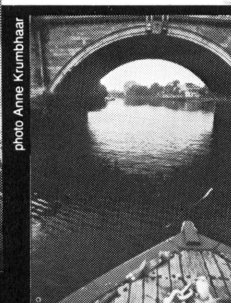
National Geographic's commitment to quality is well known. And when it comes to the production of its TV programs, it applies the same rigorous criteria. So when they teamed up with WQED Pittsburgh to produce these specials, the lab they selected for this challenging assignment was TVC.

Footage for these specials were shot under the most difficult weather conditions, in many different parts of the world. It required extremely knowledgeable handling, technical know-how, skill and judgement. Working closely with the cameramen, TVC met every deadline and achieved excellent results. The dailies always came up to National Geographic's uncompromising standards for quality and professionalism.

National Geographic's history-making ratings speak for themselves. TVC is proud to have played a supporting role.



"Egypt"—Norris Brock, Director of Photography



"The Thames"—Martin Bell, Director of Photography

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to "principal photography."

The system is also designed to be highly mobile, if not entirely mobile. To the extent that it needs a studio base away from the location the two will be connected via telecommunications. Perhaps the ultimate system will be completely contained in several large trucks which can go anywhere in the country and will require only a limited amount of temporary office space on location. In Tulsa Coppola's production company had set up in an abandoned school which was also being used for some of the photography. Since the film was being processed in Hollywood, the film cutting rooms were in the studio in Hollywood. Computer terminals at the studio communicated with the computer on location via a modem (i.e. over a telephone line). Coppola even had a blackboard on location which automatically reproduced whatever was drawn on it onto a CRT display in the editing room in Hollywood. This was also used as a storyboard sketch system. For this production cut sequences were still physically shipped back and forth in the form of videocassettes, but it is easy enough to envision a system in which dailies and/or edited sequences are instantaneously transmitted between the studio and the location.

In a sense Coppola's computer is involved in a production even before the script is written. The information processing system is designed to store all of the files and correspondence for the entire studio as well as files relating to other aspects of Coppola's life and studies. Any communication involved in the development of an idea prior to scripting could be done via the computer and stored in a file for the project. The script writing is done with a word processing program in the computer so that the script can be revised easily and stored in the memory of the computer. Coppola indicated that he had some twenty scripts stored in the computer in various stages of development. Once a script is completed or even as it is being written, it can be broken down and analyzed in every conceivable way by the computer—given the proper programming in the computer. Coppola himself is only beginning to apply his computer to all of the pre-production processes, but it is easy enough to imagine how a computer could break down a script and even schedule the shooting up to a point. More importantly each time a revision is made in the

script the computer can automatically update the information for every department affected by the revision.

To some extent the full utilization of the computer requires the development of a script format which is geared to the computer. This is comparable to the way in which a conventional shooting script is typed in a format which facilitates timing and analyzing the script for production purposes. Some form of encoding would be required to enable the computer to recognize, for example, descriptions of characters, wardrobe or props so that these items could be automatically catalogued and cross referenced. Story points could also be identified to facilitate the analysis of the script from an aesthetic or dramatic point of view. In the production of *THE OUTSIDERS* Coppola is working with a system which breaks the script down into "reels" (i.e. the same sort of 10-minute divisions that the edited film will eventually end up in) as the script is being written. He is also assigning to each scene a very brief summary of the essential action of that scene for use in analyzing the structure of the movie. This is similar to the kind of "one line continuity" frequently employed by an editor as he assembles footage for a film, except that Coppola is using it as an accessing tool in pre-production as well and designing it to be compatible with his computer.

One interesting offshoot of Coppola's attempts to integrate pre-production with production and post-production is his approach to the scripting process for a future project. For *THE OUTSIDERS* Coppola had a composer involved very early in the pre-production so that production decisions could be based on choices that had been made for the scoring. One of his ideas is to take this approach to its logical extreme and virtually score a picture as it is being scripted. He plans to start with a musical structure and script the film around that structure rather than shooting from a dramatic or literary structure and scoring after the fact.

After the script has been refined adequately Coppola records the dialogue much as a radio play would be recorded. He mixes the dialogue with the composer's initial musical "sketches", and uses this as the spine around which to construct an electronic storyboard. This storyboard can consist of sketches which have been videotaped and stored in a frame storer. It could also consist of

graphics created by means of a computer graphics system. Acquiring a paint program is one of the priorities in the development of Coppola's system. This would enable the storyboard to be created directly with the computer, and depending on how sophisticated the graphics program is, it could ultimately be used to create backgrounds for the film itself.

Coppola's mobile studio would also include a 24 track audio tape recorder and the means of processing and mixing sound effects as well as music so that the work on the sound track could progress simultaneously with the scripting and storyboarding.

Once the storyboard has progressed sufficiently the next stage is to shoot rehearsals with the actors. For *THE OUTSIDERS* many of the rehearsals were done at the actual locations where the scenes were to be filmed, so that the videotape included the settings as well as the actors' performances. The rest of the rehearsals were shot in a gymnasium with a blue backing and backgrounds in the form of Polaroids of locations were matted in electronically with an Ultimatte. Coppola concluded that this was a much more efficient way to achieve the goals of this stage and plans to use blue screen exclusively in taping the rehearsals on the next project. Matting in Polaroids of the locations can be a remarkably effective way of providing a sense of what the scene will be like in the actual production. With *THE OUTSIDERS* Coppola came up with a rehearsal "storyboard" which was a rough version of the entire film and which was complete enough to show to small audiences for reactions to use in evaluating the structure and pacing of the film. All this work is done in a matter of days and serves as a theater-style rehearsal period as well.

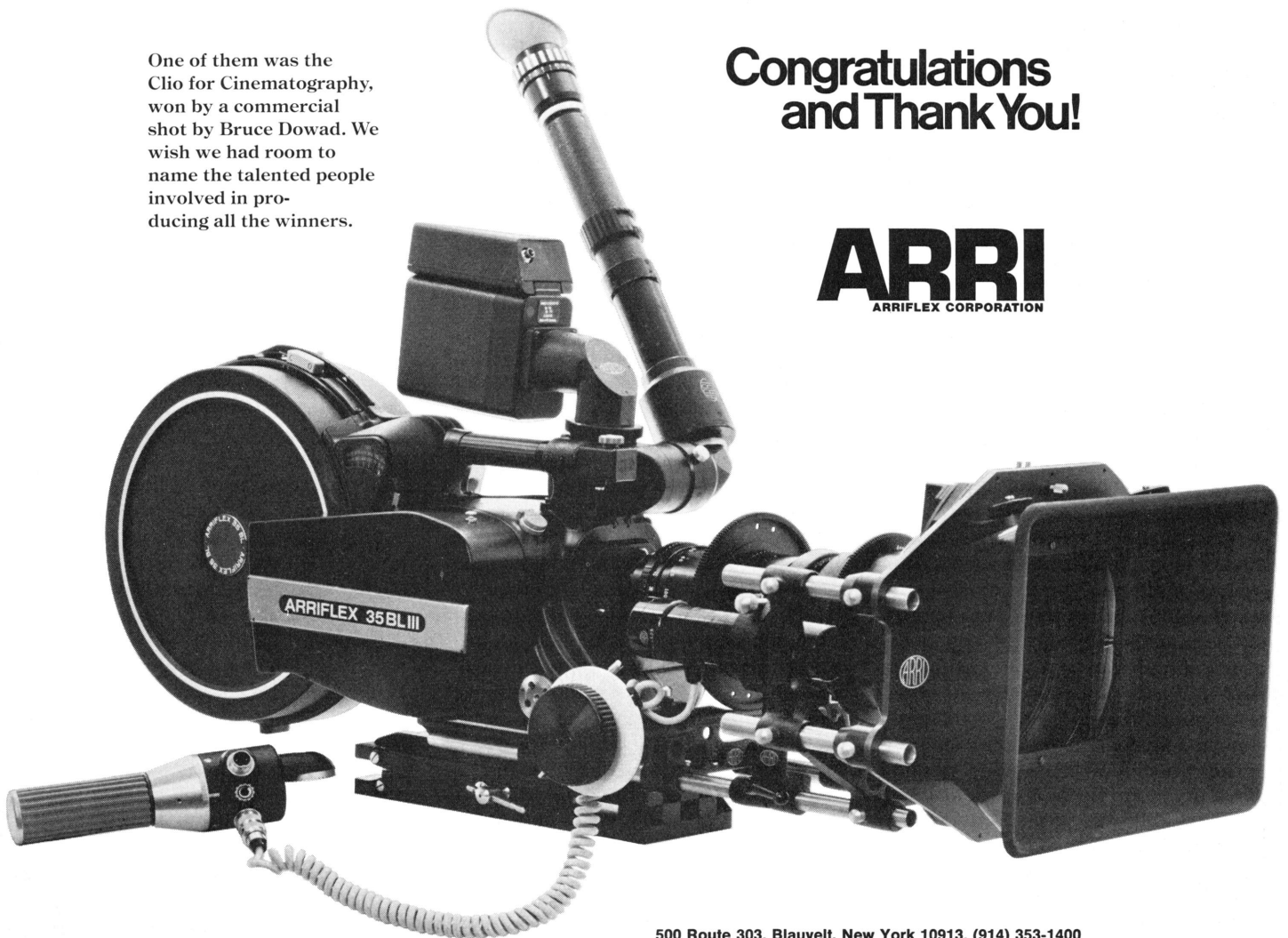
This rough videotape version of the entire film serves several purposes. The process of making it enables the director and the actors to work out a lot of problems or choices that would otherwise eat up expensive time during the actual production. The edited tape can reveal that certain scenes or portions of scenes are unnecessary altogether, thereby saving the cost of shooting them only to have them end up on the cutting room floor. Similarly it can reveal the need for additional scenes which otherwise would never be shot. The tape is also a useful reference for all the production personnel who have not been in-

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involved in the pre-production. It provides an overview of the film and gives them a better sense of how each scene will work. Basically the videotape version of the film enables the film to evolve more gradually from script to final production. Since the backgrounds can be matted in live during the taping of the rehearsals, the edited tape can be available for viewing almost immediately after rehearsals are completed.

Although the focus in the rehearsal stage is on the acting and the overall pacing, occasionally some work was done to determine how the scenes would be shot. Camera angles or moves could be plotted in some scenes, but for the most part the videotaping was simply done in wide shots designed to record the performances. In this sense the videotape differs from a storyboard which is an attempt to specify all the camera angles necessary to convey a scene.

The next stage is the full production stage. Coppola is anxious to be able to shoot a feature on high definition television equipment and even says that he is willing to accept a compromise in image quality relative to film in order to take advantage of the speed and flexibility of videotape production and post-production. He is convinced that the image quality of the prototype HD-TV system developed by NHK would be entirely adequate for theatrical films especially when transferred to film for release, but since the equipment is not yet available to him his current productions are still being shot on film.

He uses a video assist system which enables him to view the scene on a monitor or his electronic viewfinder as it is being shot and which also records the takes on 1/2 inch Betamax cassettes. Using these cassettes he can immediately begin editing on location as he is shooting. At the end of each day's shooting he will view the cassettes in order to review and refine his choices for the takes to be printed. He can communicate certain preferences to the editor in the form of notes or he may send a hastily prepared "sketch" edited from the tapes.

Editing for THE OUTSIDERS was done initially on film. A videocassette of dailies was made with scene and take numbers added to the time code; and then the workprint was edited and a cassette made of the edited scene. The videocassettes were sent to Coppola on

location, who used the video editing system to make revisions in the sequences. Anytime he inserts a new piece of film into a scene from his videocassette of dailies it will carry with it a scene and take number so that the editor can easily conform the workprint to the re-edited cassette. Eventually the negative is cut in the conventional manner.

The lined script with all the script supervisor's notes is entered into the computer each day and transmitted to the cutting room. The Xerox computer system is designed to display a full page of script on the CRT display and it has been programmed to display script supervisor's notes in exactly the way they are recorded on the shooting script.

Editor's Note: This article has had certain sections deleted from it at the last minute due to patent considerations. Coppola has been advised not to publicize one aspect of his system until a patent application has been filed, but representatives at Zoetrope have assured us that AMERICAN CINEMATOGRAPHER will be the first to publish the information once it is available.

Obviously Coppola's system is tied down by the mechanics of traditional film editing. He had an editor cutting a workprint on THE OUTSIDERS because 1) that was the way that particular editor was accustomed to working and 2) that was the simplest way to keep the film current with editing decisions made on videotape so that there would not be a delay when the time came to cut the negative. Coppola seems clearly to be headed towards the elimination of a film workprint in the development of his editing system, although the use of a film workprint permits screening the work-in-progress in a theater as a means of evaluating it. Presumably a willingness to shoot in a high definition television format for theatrical release on film assumes that one would forego the luxury of previewing a film print of the unfinished film in a theater and be content to test the film with large screen video presentations — although for a price one could order a film transfer of the workprint at any point.

The major advantages of videotape as a production medium are the speed of post-production and ease of doing special effects. Similarly speed is the principal benefit of the application of electronic technology to pre-production. Speeding up the entire production process can result in reduced costs especially when money to finance a production is borrowed at high interest rates, but with Coppola one also gets the sense that he simply likes to work fast. Being able to work fast helps him to sustain the energy and enthusiasm it takes to do his best creative work. He is also excited by the production design possibilities created by the availability of electronic special effects. Moreover, Coppola likes being a pioneer. Just as his films are aesthetically unique and outside the mainstream to some degree, his approach technically is unconventional. He sees the development of new production methods as just as valid a part of his life work as the creative aspect of his filmmaking. Certainly there is no other filmmaker who is as willing or able to experiment with electronic production techniques while producing theatrical features. He believes that electronic technology can be a tremendous boon to filmmakers, but that it can only be developed properly by filmmakers. Without experiments like his the equipment manufacturers will take all their cues from broadcasters, who he feels have an entirely different set of priorities when it comes to the creative use of images and sound. If, as he predicts, these electronic production techniques become the standard in five years, the industry will be greatly indebted to him for the risks he took on ONE FROM THE HEART and THE OUTSIDERS. ■

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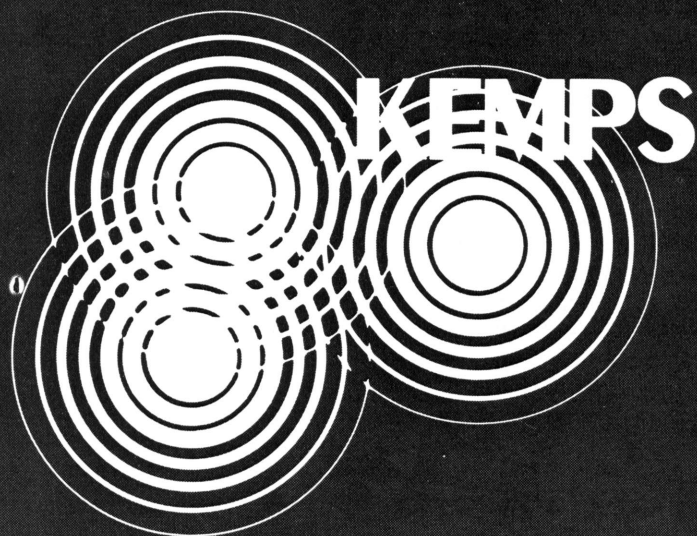
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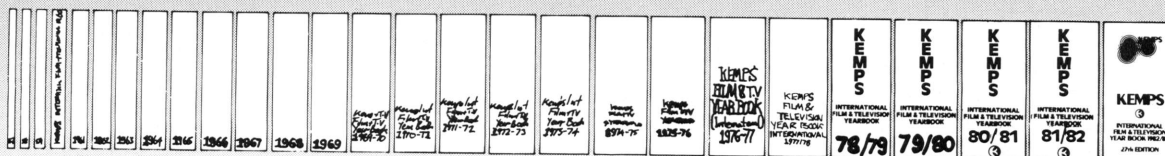
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Computerized Music Editing

If you are an avid credit reader you may have noticed an unusual credit at the end of CONAN: Tempo Editing by MusyncTM. The reason you probably never heard of "tempo editing" before is because no one ever had to describe in three words or less the contribution of a unique computerized music editing system invented by Robert Randles, a composer and music editor. Randles has been developing and using Musync for several years, but CONAN was the first time the system was given a screen credit. When the time came to prepare the credits, no one knew exactly how to credit his system so they invented the term "tempo editing."

In order to understand what Musync does, it may be helpful to review the function of a music editor. Some people assume that a music editor merely times scenes to be scored and then splices together the recorded music in sync with the picture. In reality, however, the music editor's job is a much more complex task requiring a combination of musical, mathematical and dramatic analysis—especially in the preparation of the notes for the composer to use in scoring. One aspect of this work is assistance in the calculation of tempos so that the musical beats can be synchronized to specific frames in the picture or the calculation of beats for a gradual transition from one tempo to another. Usually the calculations required by the use of variable tempo would be complex enough so that a composer resorts to some other technique to achieve a similar effect or uses free timing. Free timing requires that the conductor work without a click track and hit cues simply by watching a clock. There are books filled with tables used in calculating tempos and beats, and it was a lecture by the late Ruby Raksin, author of *A Technical Handbook on the Mathematics of Motion Picture Music Synchronization* that initially started Randles thinking about a computerized music editing

system. In essence he figured there had to be an easier way, and he set about inventing it.

One of the results of his work can be illustrated by an example from his work on CONAN. There is a fight scene in CONAN which was edited to a temporary piece of music in which the tempo gradually sped up. At the beginning of the fight there was a musical beat about every 20 frames while at the end the beats came about every 9-7/8 frames. In between there were, of course, numerous pieces of action with which the music needed to be synchronized. This may have been a very effective tool for the picture editor, but it was a music editor's nightmare. When Randles and Basil Poledouris the composer, analyzed the sequence and realized what they were up against, Poledouris' parting words to Randles were, "Good luck!" Randles went back to his cutting room, and then called Poledouris in a few minutes to say, "I've got the sheets for you. Do you want me to messenger them over to you?" He also already had a click track recorded for Poledouris to listen to. He was able to do this because he had a computer terminal in his cutting room which was connected to the Musync computer in Pasadena by telephone.

The prototype Musync system built around a UF-16 with a CRT for the computer and a video monitor for displaying the visual cues.

Musync began as a computer program to facilitate the making of click tracks by calculating the position of each beat. It would print out a beat list indicating precisely where a piece of film would have to be punched. It gradually developed into a complete music editing system in which a Cinema Products U/F-16 or U/F-35 editing console is hooked up to a computer which prints out custom tailored scoring sheets, creates a click track and produces visual cues on a video monitor to aid the conductor in anticipating tempo changes and specific cues. The entire system is portable enough to be installed in a normal cutting room and moved to the scoring stage for the recording session. It can be synchronized with a projector by means of a reel of SMPTE time code played in interlock on a recorder.

The music editor begins by viewing a work print on the editing console to make spotting notes for the music cues. Although the prototype was built with a Cinema Products/U/F-16 before the 35mm configuration of the editing console was available, the counters on the UF-16 can be set to read out in 35mm footages and Randles works with a 16mm autopositive dupe from the 35mm workprint. Musync can be



$$: 4\varnothing, \varnothing\varnothing :$$

AM:Doc - not yet back to earth. Unfocused marble-like eyes hide his terror.

AN: Vincent's concern becomes frustration, until, to break the tension...

A0:...he SLAPS his pencil down on the desk in exasperation.

AP: "I'm calling Elaine and telling her you're coming home."

AQ:He GRABS the phone.

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BEYOND REASON

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91	007	feet	1	frames	1	prongs	1
92	007	feet	1	frames	1	prongs	1
93	007	feet	1	frames	1	prongs	1
94	007	feet	1	frames	1	prongs	1
95	007	feet	1	frames	1	prongs	1
96	007	feet	1	frames	1	prongs	1
97	007	feet	1	frames	1	prongs	1
98	007	feet	1	frames	1	prongs	1
99	007	feet	1	frames	1	prongs	1
100	007	feet	1	frames	1	prongs	1
101	007	feet	1	frames	1	prongs	1
102	007	feet	1	frames	1	prongs	1

[illegible]

Two sample pages printed out by Musync for Randles work on BEYOND REASON. The top is a page for scoring music cue 8M4. The numbers across the top of the musical staves are the beats and the vertical lines to the codes for the comments (AM, AN, etc.) indicate precisely the point to which the comment refers. AP indicates a line of dialogue and the arrows underneath it indicate the duration of the dialogue. The bottom page is a portion of the beat list specifying the precise sprocket where the beat falls.

set to calculate in either 16mm or 35mm footages. It is also capable of being adapted for use with any video-cassette deck which plays SMPTE time code. It was designed for film use first because there was a more immediate need for it in film and because the design problems with film were the more difficult. Musync can be used with any film transport system capable of generating SMPTE time code with a shaft encoder. An editing console with an electronic footage counter already has the necessary hardware in it.

Although the editor can operate the editing console with the conventional manual controls, additional circuitry was designed to permit control of the UF/16 via the computer terminal with designated keys. There is a simple set of keys for forward, reverse and half-speed forward. There is also a key to advance one frame at a time and an adjustable "tab" key to advance or retard 8 frames at a time (or any other pre-set amount). Other keys will advance or retard 3 seconds at a time. The CRT display for the computer makes these controls much simpler than they might sound in a written description like this because of the format Randles has designed for the CRT display. It consists basically of rows of marks where each mark represents a frame and each row contains 72 frames or 3 seconds. The cursor on the screen moves across the rows in exact sync with the picture so that once the system is lined up and locked in, the CRT display provides an immediately accessible graphic representation of where you are in the reel as you view the picture. The key which moves the cursor directly up or down to the row above or below it is the key which advances or retards the picture 3 seconds. Similarly there is a "page" key or a "back page" key which will move the picture to the next or previous set of rows displayed on the CRT.

The number of rows displayed on a given "page" varies with the number of comments that have been entered. The computer is also tied to the footage counter so that you can command the machine to go to any specific frame in the entire reel by entering the footage and frame via the keyboard. Once cues or comments have been entered into the computer, you can also command the machine to go to any place there is a specific cue or comment by entering the code for that cue or comment.

(Music cues are given the standard "2M3" type of designation and other comments are automatically given a two-letter code). It is also possible to enter a specific beat number for a cue or a specific number of seconds into a cue and the machine will go there. Or you can go to the next beat or the next comment or the last beat or comment. Suffice it to say that the keyboard provides a very efficient means of cuing up the picture in any way a music editor might desire. The cursor can also be unlocked from the film transport so that you can go back and modify an entry in the computer without having to run the film back and forth. You can always lock the system back together in sync by simply entering the footage and frame where the picture is parked.

One unique and impressive result of designing the system to control the film transport is that it is possible to stop the picture on the precise frame where a button is hit. Many editing tables have some degree of delay between when the stop switch is hit and when the picture actually comes to a complete stop. What Musync does is to make note of the frame where the button was hit, slow down to a comfortable stop and then back up to park on the precise frame. Needless to say this is a good bit gentler on the film than trying to make it stop instantaneously when a stop button is hit.

As the editor views the picture, he can enter comments about the action into the computer. If there is a door slam at 23 feet 6 frames, he stops on that frame and types in "door slam" or whatever comment he cares to make. The computer automatically labels the comment with the next available designation so that the editor never has to worry about whether his last comment was BD or BE. The cue label appears directly above the frame mark on the CRT, and up to one line of the comment appears at the top of the CRT. When the sheets are printed out, the entire comment will be printed above the appropriate bars of the scoring sheet. If there is more than one comment for a given frame, they can be "stacked" on different levels in the computer and then printed out one above the other on the scoring sheet. If the editor is commenting on a sustained effect or a line of dialogue, he can enter the out point at the appropriate frame with a single button.

The beginning and end of a music cue are entered in the same manner, and it is possible to enter alternate versions of the same cue, any one of which can be printed out on the scoring sheets.

Musync enables the editor and the composer to select the best tempo for a particular sequence in a variety of ways. It is possible to specify the beats by hitting the space bar on the keyboard. Thus a composer could view a sequence and create the most complex kind of variable tempo by simply tapping the keyboard as he goes. Or if the composer knows he wants to work in a specific tempo, Musync will immediately tell him where the beats would fall in relation to the picture by displaying a + at every frame where there will be a beat. If the composer wants to adjust the tempo so that a beat falls on a specific frame to coincide with the action, the editor tells the computer to move that beat to the specific frame and then to "fix" everything up to that point. The computer will automatically adjust the position of the beats leading up to that frame so that they are evenly spaced. If the composer does not want to modify all of the beats up to that point, he simply picks a place where he would like to start making the adjustment, and the computer will "fix" only the beats between there and the specific frame, i.e. the computer will retard or accelerate the tempo to make the beat fall on the frame. An even better solution may be to choose a different tempo for a section which includes the piece of action and have the computer calculate a gradual transition between the first tempo and the second tempo over a specified number of frames. The viability of this technique is insured by the visual cues which augment the click track for use in recording.

Another feature of the system grew out of Randles' work with Poledouris on CONAN. Poledouris often likes to assign a certain number of beats to one section of a cue and retard the tempo for the last two bars leading up to the next cue point. Ordinarily he would free time a section like this, but Musync can provide an alternative. It is possible to designate a specific number of beats for a cue and then the number of beats for a retard and the degree of retard. The computer will make all the necessary calculations and immediately play

back a click track in sync with the picture. If the effect is not what you had in mind, the degree of retard can be changed and the computer will immediately "fix" all the other beats. Again this approach is more feasible because of the visual cues which can be used with the clock track or as a backup for free timing.

Ordinarily many composers shy away from variable click tempo click tracks because they find it difficult to anticipate the changes in the tempo while conducting. Randles has devised a visual cue which enables the conductor to anticipate each beat perfectly. It consists of two colored squares about 1" square that move from the right and left edges of the screen to meet in the middle right on the beat and then bounce back to the edges and return for the next beat. Having two squares colliding in the center of the screen rather than one hitting an edge of the screen makes it much easier to anticipate when the beat will come. These cues moving back and forth near the top of the screen can be supplemented with similar pair of colliding bars at the bottom of the screen which cue the downbeats. A streamer can also be generated in the form of a bar which moves from one edge to the other in two seconds or whatever time has been set. In addition the screen can be made to display little green crosses representing each beat in a measure. A cross disappears as each beat occurs until the next measure is reached and a full set reappears. Blue numbers can also be used to display either the number of beats you are on or the measure that you are in. All of this information can be keyed into a video image of the picture if a video camera is attached to the U/F-16 console or if the work is being scored in conjunction with a videocassette. The cues can also just be displayed by themselves on a small monitor on the conductor's podium. The colors and the nature of the cues make it easy to see them out of the corner of the eye while also reading the music or watching a projected image.

Once a music editor has completed his spotting and breakdowns and entered the known tempos, the system will print out several different forms or lists. First of all it can print out a conventional set of spotting notes giving the start and stop footages for each cue and the timings or footages within

a cue for specific bits of action. More importantly, though, it prints out music paper with several sets of musical staves and a graphic representation of the beats and the cues. Randles originally designed the system to print out one continuous sheet of music paper that folded into booklike pages with each inch representing one second and a mark for each frame of film. After conferring with several composers he redesigned the format to print out separate 8½ x 11 pages containing 10 seconds of music each. The comments are printed above the music staves and the frame to which the comment refers is indicated. The system also prints out a beat list that indicates the exact footage and frame or fraction of a frame where each beat falls. Even though Randles no longer needs to punch click tracks because the system generates a click track, nonetheless he still finds the beat list a useful reference in some situations.

If a change is made in the picture editing after the music spotting has been done, it is a simple matter to update all of the comments, cues and beats. The precise footage that has been added or deleted is inserted at the appropriate place in the computer representation of the reel, and all of the footages for the comments and cues affected by the change will be automatically corrected. Then the beats in any musical cue can be "fixed" in the appropriate manner by simply telling the computer to "fix" the existing beats or by changing the number of beats and "fixing" them. When the system is used on the recording stage, changes can be made literally up to the last minute without necessarily sending a music editor to an early grave.

One of the first sequences scored on CONAN was the attack of the Cimmerian village in reel one. Poledouris wrote an elaborate piece of music in October which was very tightly synched to the action. The scoring session was scheduled for January, and as he worked on other sequences in the film Poledouris repeatedly checked with Randles to make sure no changes had been made in the Cimmerian village sequence. It became a bit of a ritual between them. Poledouris would begin each telephone conversation with "They haven't made any changes in the attack on the Cimmerian village, have they?" True to form the changes in the attack on the village came through right before

Christmas, when Poledouris was busy trying to complete the rest of the score. Drastic recuts were done on the whole sequence, totally subverting the sync between the music as it had been written and the picture. Fortunately Musync was able to lay out the sequences in a way that enabled Poledouris to revise his music to conform to the re-edited picture. By moving specific beats around so that they once again lined up with the appropriate pieces of action, it became much easier to see where and how the music could be adapted.

The ultimate objective in the development of Musync is the liberation of the composer and the music editor from numbers so that they can concentrate on music, picture and sound. While some film editors balk at the use of a keyboard to control an editing system, a music editor is probably accustomed to typing his notes and music cues as he views the film on a Moviola or a flatbed. Having the typewriter keyboard control the editing console only simplifies his work, and the electronic nature of the Musync "typewriter" makes it easier to correct mistakes or alter the wording of a comment.

With the right people using it Musync can greatly open up creative areas which would otherwise be inaccessible to a composer or make things possible that would normally just be too much pain and bother. It will probably change the working relationship between a composer and his music editor so that there is a great deal more interaction between them and the music editor's involvement in the creative process is greatly enhanced.

Musync also has potential for application in Foley, ADR and subtitling. The visual cues could greatly facilitate Foley work, and the ability to enter comments which are tied to specific frames of film could easily be adapted for dialogue replacement or translating. The different levels for comments could even be used to store different language versions of dialogue.

Randles has only one prototype of Musync, but he is preparing to have others built to be leased. For further information contact Robert Randles at (213) MUSIC 35 or c/o APh Corporation, 285 West Green Street, Pasadena, CA 91105. ■



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Creating Visual Effects For

By CLARENCE W. D. SLIFER, ASC

I lived with *GONE WITH THE WIND* almost 16 hours a day for about 11 months. Along with Jack Cosgrove, head of the Special Effects department of Selznick International, I was involved in the preparation and making of the picture from the beginning. In spite of it all it was a wonderful experience.

The Selznick International Company was a very young organization, and the making of a picture of that magnitude

was almost staggering. Also, at the time that we were making *GWTW* we made *INTERMEZZO*, Ingrid Bergman's first American picture, and *REBECCA*, Alfred Hitchcock's first American picture.

Before telling you about *GWTW* let me brief you about the events leading up to the picture. In the spring of 1936 I was sent on location by Technicolor to work on David O. Selznick's *GARDEN OF ALLAH*. It was only the second picture made with

many exteriors using this Technicolor 3-color process and the first to use many matte painting shots. Jack Cosgrove, ASC, was in charge of these shots for the picture. As I had worked with Jack many times from the old Pathe-DeMille studio days, I was assigned to work with him. This was a new experience for both of us—making matte shots in color with the 3-strip camera. Due to the construction of the 3-strip camera and its matte box we



G.W.T.W.

were forced to enclose the camera and the matte glass in a small tent-like structure. This was very crude. So, for the next Selznick picture I designed a special matte box which could hold the Technicolor R.L. lens as well as three matte glasses and could attach to the Technicolor tripod head and require no tenting. I mention all this to show how, little by little, we were able to get together the means to be able to work on a picture like GWTW. It was most difficult to make a matte while looking through the camera with the lens's photographic stop) since the matte changes with the stop. On a later picture I had a heavy line-up finder made. It was calibrated to match all of the Technicolor cameras, and it could use all of the Technicolor lenses. Thus it was easy to make a matte, and while doing so we did not tie up a Technicolor camera.

Jack was a great man for spotting opportunities for matte shots and to convince the director that he needed them. So we returned from location with many shots. In those days nothing was duped, and we worked on only the original negative. Jack had taken over the old trick department that Dewey Wrigley, ASC, had had at Pathe Studio. The only thing we could use was a cement camera-pedestal, a fixed painting easel for photography, a generator for lights, and the dark room. This being a color picture, and with the film balanced for daylight, we had to find incandescent lights and filters that would make them match the color temperature of daylight or arc. We found two old Mole-Richardson rifles with 2000 watt bulbs and had filters made for them.

We were now in business. Jack did all the painting, and I did the photography. Each day I would bring out from Technicolor several scenes loaded in magazines and a Technicolor camera, D5 as I recall. It immediately became apparent that we needed an easel that would move the paintings up and down and sideways, because when the camera was taken off the camera pedestal at night for servicing and then remounted on the pedestal it did not always return to

its original position, so the painting would be out of register for the camera. Also, if another camera and lens were used the size would be wrong. Another thing that was needed was a variable speed motor for critical balancing of the painting exposure against the original photography. The longer the film was held the more the latent image of the original exposure would change in density and color. We also needed a better way to project the small piece of negative of the original photography so that a pencil outline could be drawn of the scene upon a neutral painted glass or masonite board—about 30" x 40" in size.

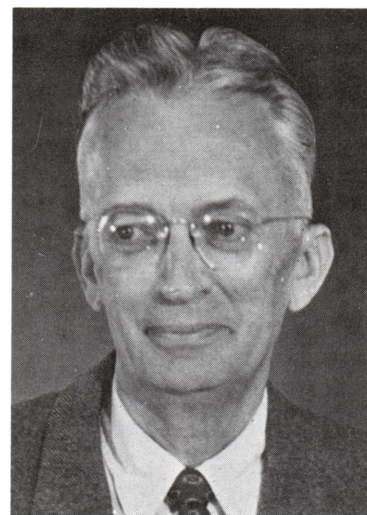
Jack laid out several shots and roughed in the painting for color based upon the colors seen in the short piece of film of the original photography that had been processed and printed by the lab. We soon tested several scenes and sent them to the Technicolor lab. Each scene was in a separate magazine holding three rolls of film. This was known as a group. These three undeveloped rolls of film had the blue, red, and green exposures of the original scene on which a portion had been matted out so that we could add to this scene by paintings, i.e., a night sky with stars, a building, or whatever was necessary. As each group was placed on or taken off this camera, it had to be carefully synched to keep the three films in register and also the proper footage noted to keep the films in sync for action.

In order to arrive at the proper balance for exposure and color, a small piece of the matted original film would be exposed of the painting with a temporary matte. This would be developed in the dark room with "hand test" developer that Technicolor furnished. At the head end of each scene, when we were on location, we had photographed about 400 feet of film without action so that we could make hand and lab tests. On this 400 foot piece of test film we would use about 18 feet for a composite test which would be sent to Technicolor for developing and printing. We then would take the returned Technicolor print and make it into a loop for the projector. This could be run for as long as was necessary to see how we were progressing with the shot. When we thought it was okay Jack could run it for Mr. Selznick's approval or criticism before the scenes were finished and sent to the lab.

With a great deal of anticipation Jack and I waited for our first efforts to return

Clarence W. D. Slifer took up photography as a hobby at the age of 10 in his home town, Kansas City, Mo. He progressed from box cameras to Graflexes, to 16mm and 28mm movies, and Agfa and Autochrome color plates. While studying architecture at the University of Washington, he decided to make photography his profession and went to work in a portrait studio. In 1927 he entered a photo contest and won a chance to join the Pathe-DeMille Studio in Culver City as an assistant to a leading cinematographer, Arthur Miller, ASC.

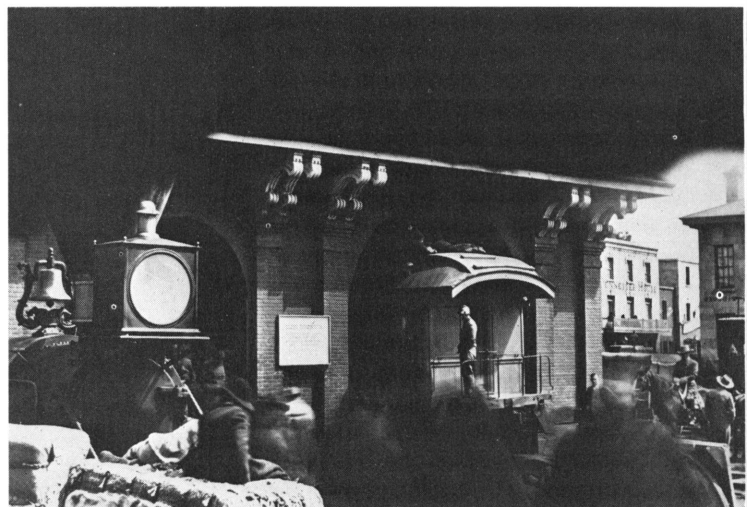
In 1932 he joined the Camera Effects Department at RKO Radio,



which had purchased the Pathe lot, where he worked on KING KONG, SON OF KONG and other memorable pictures. He worked for Technicolor for a while during 1936, and before the year was over he assisted Jack Cosgrove, ASC, in creating photographic effects for David O. Selznick Productions' THE GARDEN OF ALLAH at Pathe.

Slifer remained with Selznick until 1953, contributing distinctive visual effects to all of the company's productions, including ADVENTURES OF TOM SAWYER (remember Injun Joe falling into the bottomless pit?), THE YOUNG AT HEART, DUEL IN THE SUN and THE PARADISE CASE. He won an "Oscar" for his work in Selznick's last American-made picture, PORTRAIT OF JENNIE. During this time he was loaned to Samuel Goldwyn for THE NORTH STAR, UP IN ARMS, THE PRINCESS AND THE PIRATE and HANS CHRISTIAN ANDERSEN. He then became a Director of Special Effects Photography at 20th Century-Fox. Later, he worked at MGM. He is now retired and lives in San Diego.

The great wall from KING KONG beginning to crumble at the climax of the burning of Atlanta sequence. This is a duped composite in which 72 fps footage of the fire was combined with normal speed photography of the horse and wagon in the Technicolor 3-strip optical printer.



The set for the Atlanta train station sequence is shown at left. The partial locomotive is a mock-up. At right, the scene is matted out and photographed for compositing.

from the lab. When it did arrive it was worse than awful—it was a calamity. The colors did not match, and the densities between the painting and the original photography were wrong. Nothing matched our own previously developed hand tests. What was wrong? In those days you analyzed your shots by looking at the exposures on the blue, red, and green negatives. This you did for both color and exposure balance. Both Jack and I had a great deal of previous experience in working with black and white, but this new 3-color photography was proving to be something different.

Meanwhile, we were making more matte shots on the set at the studio, with the cutter, director, and Mr. Selznick

wanting to know how soon they were going to see on the screen some of the location shots. Each day when we sent something to the lab we were getting deeper and deeper in trouble. Our hand tests were matching, but what came back from the lab did not. As each hand test took over 20 minutes to develop, and together with the time it took to photograph the painting, we could figure on about an hour for each test. So Jack and I were putting in some long days and nights. We were trying to match the lab also by making density wedges of exposure and putting the test through at the exposure that looked best. That helped, but it was very difficult to match subtle colors. This could be done by hand testing

only. Much time could be saved with this method. As we kept adding new shots to our backlog of unfinished shots, the pressure from the front office increased. The best part about our dilemma was that what we were doing was new and untried and that no one else knew any more about what to do than we did. Then we had a giant stroke of luck!

One night before we were ready to send a test to the lab we decided to check the line-up. As it was quite late and I had already thrown out our hand test developer, I had to mix up a new batch. The Technicolor hand test developer came in packets for each chemical, and you had to dissolve and mix them. One of the

Continued on Page 835

The fire scene created by Lee Zavitz. The burning buildings are old sets from Pathe, Cecil B. DeMille and RKO-Radio productions. Four sets of stunt people, horses and wagons were utilized.





The Atlanta station scene as completed on the original negative. The matted scene (facing page) was rewound and combined with the painting and the smoke coming out of the stack. This was the first scene completed on a specially designed aerial image optical printer.



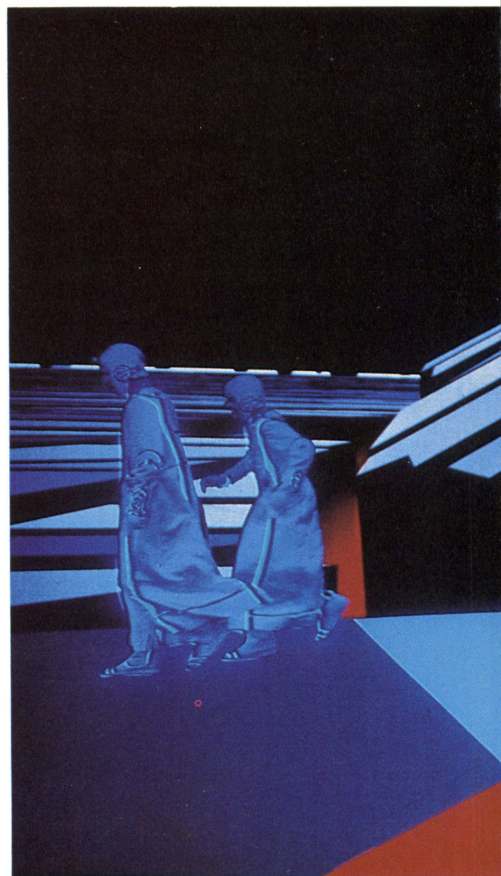
The last view of the mass of wounded men at Atlanta. About 1,500 extras and 1,000 dummies were used on the set. More bodies, wagons and other details were added by the matte artist to the upper portion of the scene. More than 100 matte paintings appear in GWTW.

The Making of

TRON

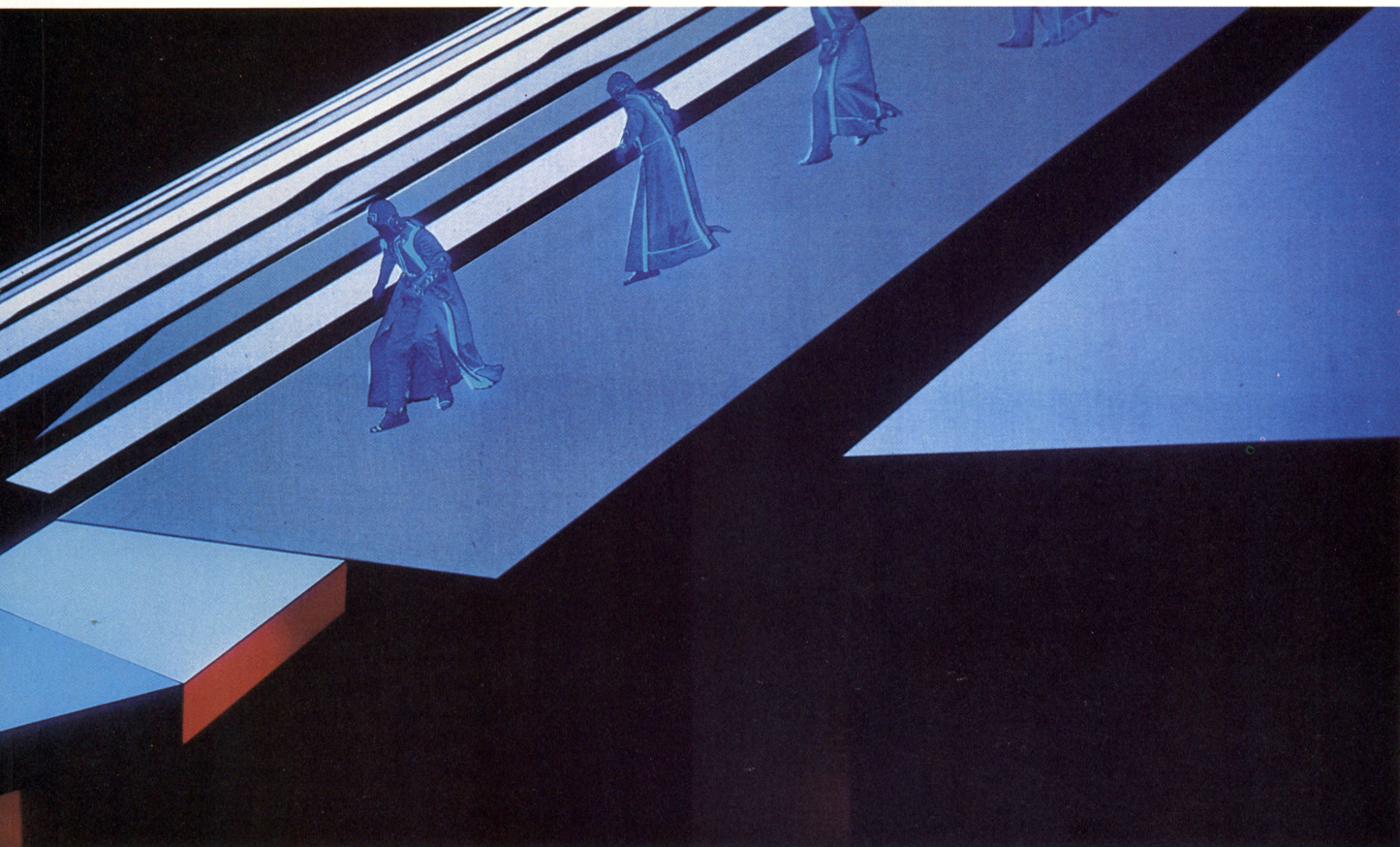
By RICHARD PATTERSON

Tron (Bruce Boxleitner) is a security program who still believes in the existence of users and who is instrumental in the overthrow of the tyrannical Master Control Program. His glowing circuitry was created by photographing him in a white costume with black lines on it and then using backlit animation techniques to add color and effects.



"Computer technology is like photography. Photography alienates people with techo-talk about f-stops and ASA and before you know it you've got a whole clique; and everybody feels left out. Computers are really like that." Steven Lisberger is discussing the origins of TRON. "So when I saw video games for the first time, I thought, 'These games are something I can relate to.' I was fascinated by them, and I wanted to do a film. I was starting to think how I could do a film about this, and immediately—I mean that same instant that the idea came to me I realized that there were these techniques that would be very suitable for bringing video games and computer visuals to the screen. And that was the moment that the whole concept flashed across my mind."

The techniques that Lisberger is referring to are backlit animation techniques he had been using in making commercials and educational films in Boston as well as computer animation techniques he had been keeping track of. At the time he was 26 and had been making animated films for four years. One of his first animated shorts had

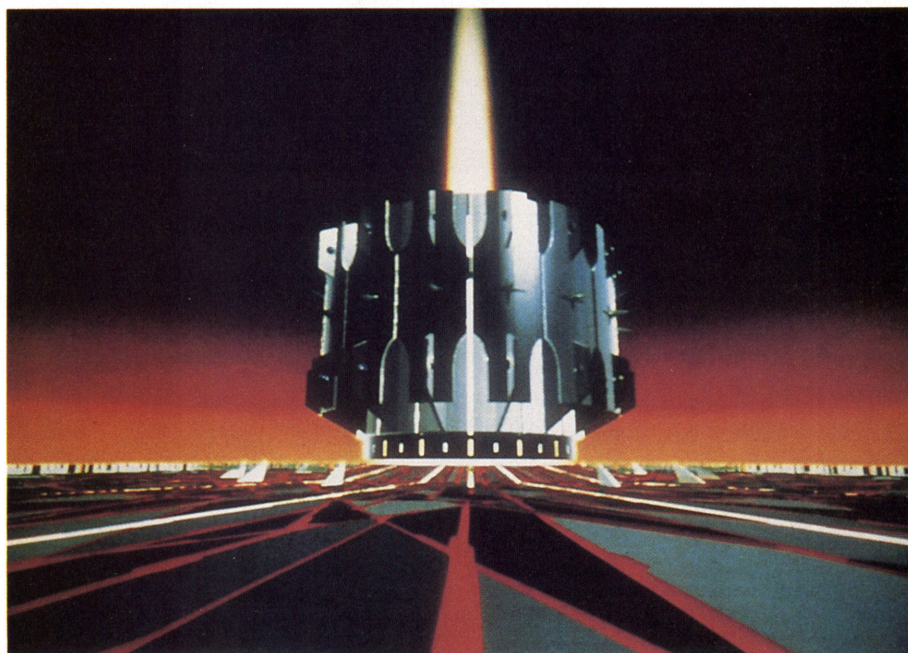


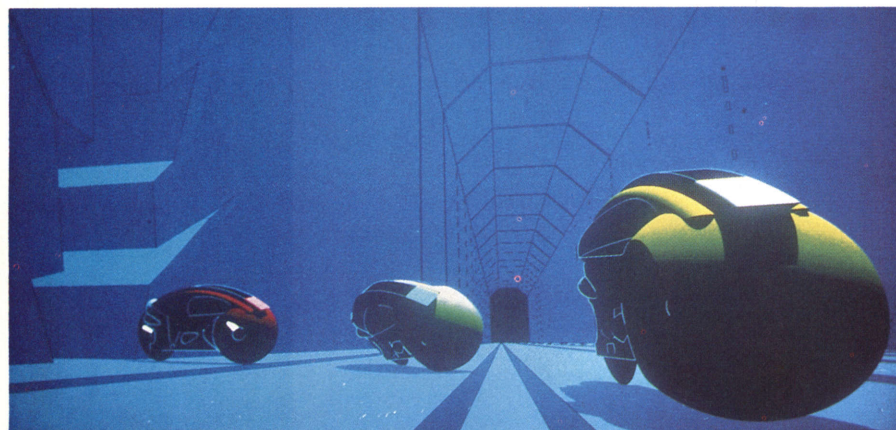
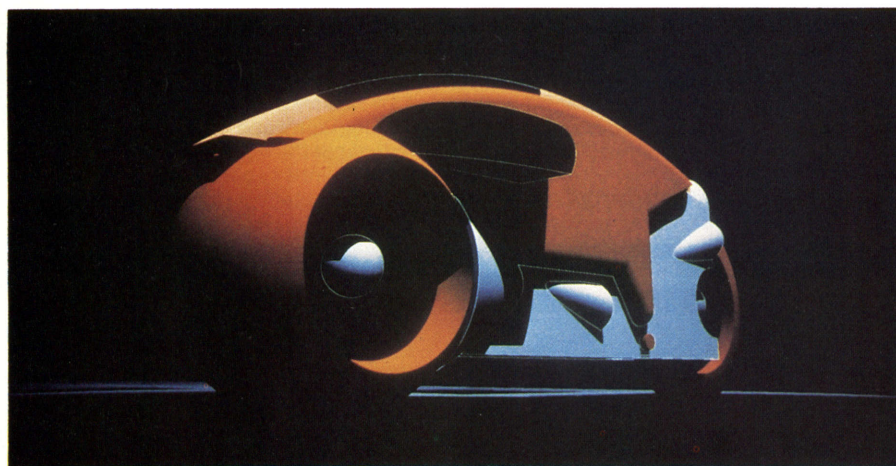
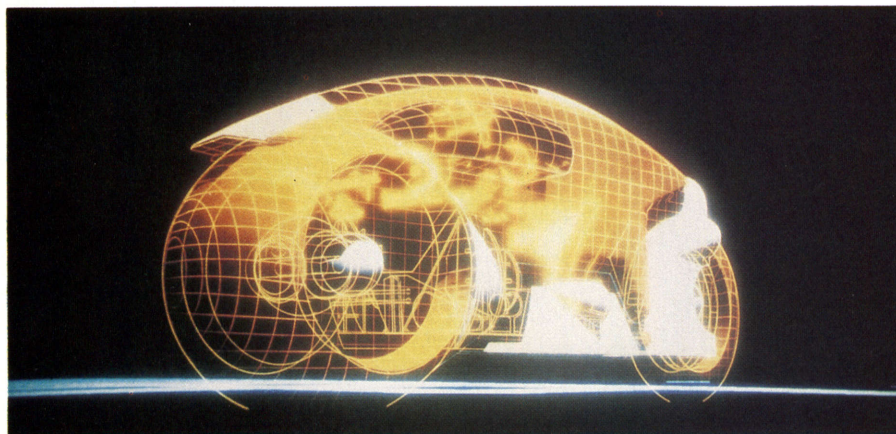
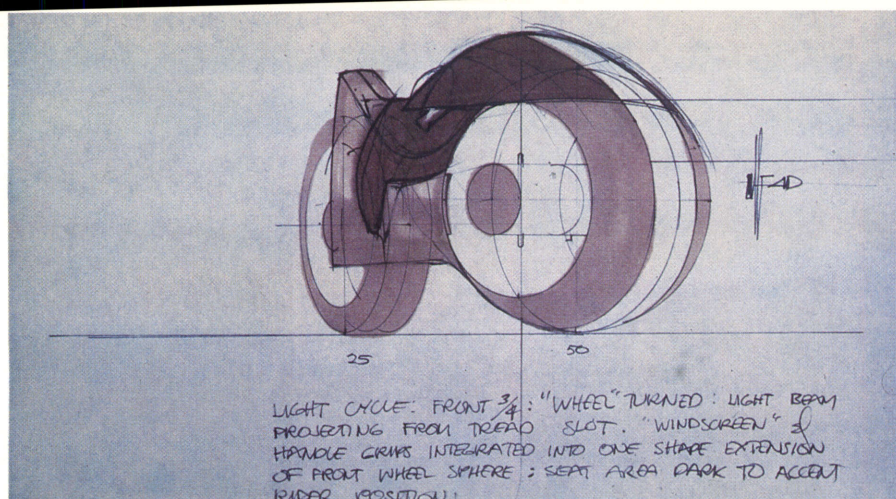
All photographs ©MCMLXXXII Walt Disney Productions

been nominated for a Student Academy Award, and he had done work for ABC and PBS. He received a \$10,000 grant from the American Film Institute to do a six minute animated parody on the Olympics and then teamed up with Donald Kushner, an attorney and theatrical producer in Boston, to develop the idea into a feature length animated film for television. With funding from NBC, Kushner and Lisberger moved to the west coast to set up an animation studio in 1977, bringing with them a treatment for TRON.

TRON is a story about a computer genius named Flynn (Jeff Bridges) who is trying to get the goods on an unscrupulous former boss, Dillinger (David Warner), by breaking into his computer system. A laser security device blasts Flynn and "digitizes him, i.e. converts him into an electronic counterpart of himself existing in a realm "inside" a computer, where computer programs are alter-egos of the programmers who created them. It is a world dominated by a Master Control Program (MCP) whose murderous henchman, Sark, is the counterpart of Flynn's real life adversary Dillinger. Flynn is sentenced to die

(ABOVE) Liberated programs flee down the ramp of the Master Control Program in an image created by combining black-and-white live action photography and a computer generated background on the animation stand. (BELOW) The exterior of the Master Control Program as seen in an image generated by the computer at Information International, Inc. Once a mathematical model for an object and its environment have been entered into the computer memory, the computer can generate scenes in which the object is seen from any conceivable angle in any kind of light. The computer could also animate the explosion of the MCP by having its parts fly off in different directions.





on the video game grid, and the bulk of the film depicts his struggle against the MCP with the aid of Tron, an electronic warrior (Bruce Boxleitner), and other programs.

TRON was originally conceived as predominantly an animated film. The story would be set up with live action and then once the hero entered the realm of the computer reality the visuals would become a combination of computer generated imagery and backlit animation. Lisberger and Kushner planned to do the film with independent financing, and one of the things Lisberger had been doing was talking to various computer image companies about techniques which could be used for sequences in the film. Lisberger recalls his early visits to companies like the Mathematic Applications Group Inc. (MAGI) and Information International Inc. (Triplé-I) with amusement: "You gotta understand at this point I was really not connected to anything. It was that tenuous position where you're going and telling these people that one day you really are going to do something with them, and they're going, 'Mm hmmm, sure you are.' In the end I think they were more surprised than anybody that it actually occurred. I had been threatening them with all this work that I was going to bring them one day saying they better be ready; and they said, 'Yeah, that should be the problem.' And then it finally happened."

In his visits to Triple-I Lisberger met Richard Taylor, who had recently joined the company after six years with Robert Abel and Associates where he developed the famous "candy apple look" in television commercials. Discussions between Taylor and Lisberger gave birth to the idea of using live action photography as the basis for the backlit animation work in the electronic sequences. By shooting the actors in black-and-white in some kind of limbo it would be possible to blow up each frame onto continuous tone and hi-con Kodaliths which could be used like animation cels in conjunction with other elements. Color would be introduced with back lighting and filters and the net result would be a visual style which was tied to the live action photography of the real world

Syd Mead's original drawing for the light cycle. The effect of the light cycle "rezzing up" around the driver was achieved by conventional backlit animation. The fully resolved light cycle was generated by the computer at Mathematical Applications Group, Inc. as were all of the images in the chase sequence.

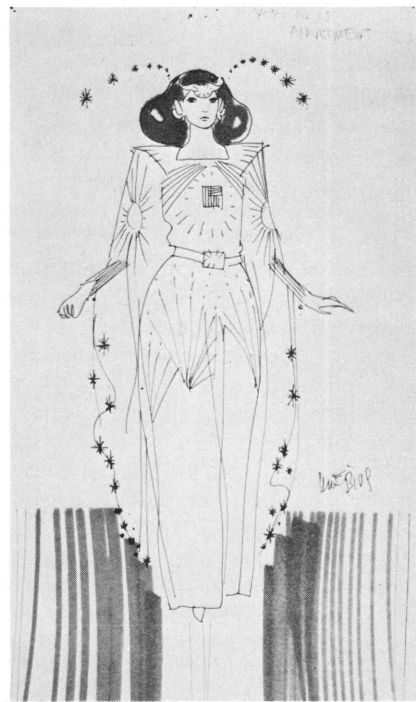
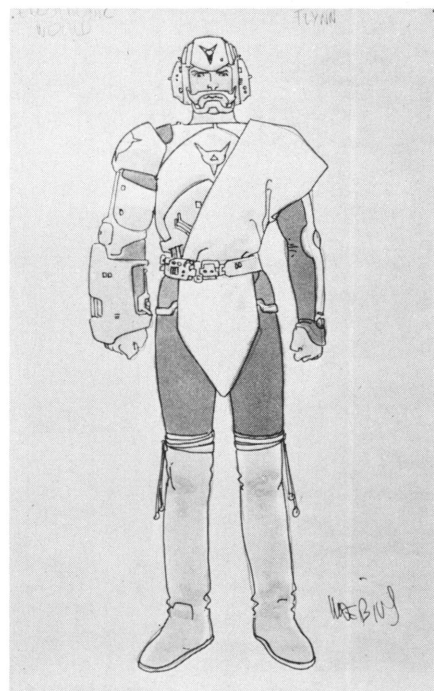
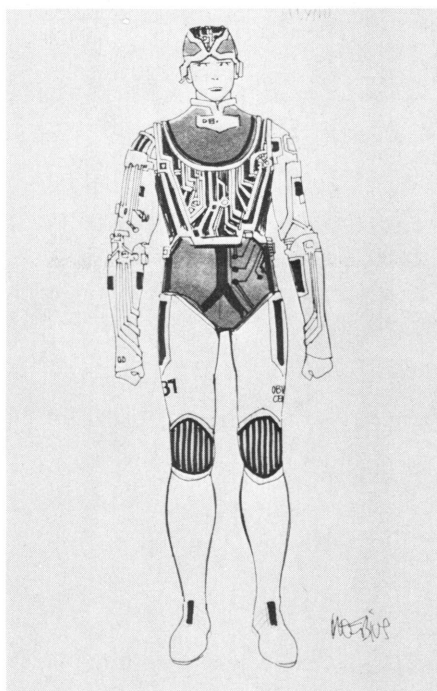
sequences and yet could be compatible with computer generated imagery to be used in portions of the electronic sequences. Lisberger did some tests with still frames to demonstrate the look that could be produced with this technique.

By this time Lisberger had already storyboarded the film completely with Bill Kroyer and Jerry Rees, two animators who had worked on ANIMALYM-PICS. Actually because of Lisberger's own background in animation, the storyboarding was done hand in hand with the rewriting of the script. Every shot required for the film was represented by a drawing in the storyboards. Some computer animation tests had been done as well to demonstrate the feasibility of using computer generated imagery of a theatrical picture. All in all Kushner and Lisberger had put about \$300,000 into the development of TRON. Efforts to secure \$4 or \$5 million in private backing reached a standstill even though a group of distributors was interested in funding the project, and Kushner and Lisberger decided to take the idea to Disney. There was a new regime at Disney committed to embarking on more adventurous productions, but even they hesitated to go with both a first-time producer and a first-time director on a production based on techniques which had never been used extensively in features if at all. The people at Disney also estimated that the film was more likely to cost \$10 or \$12 million.

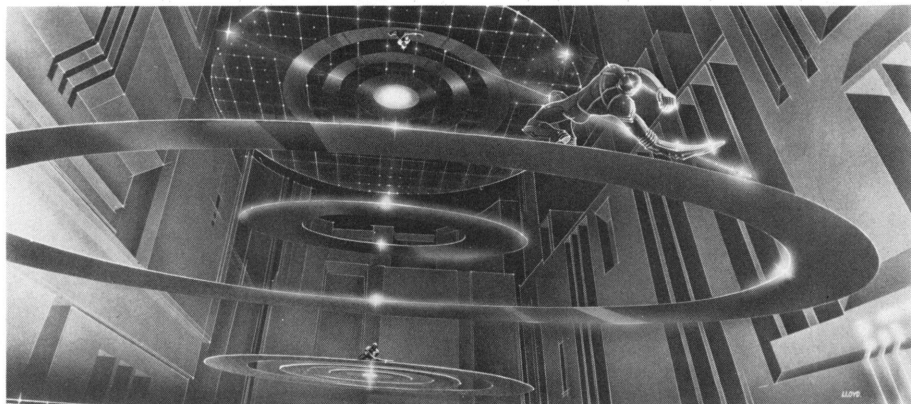
Eventually Disney agreed to finance a test reel with samples of computer generated footage from MAGI and Triple-I combined with some live action scenes designed to demonstrate exactly what the backlit composite effects would look like. There was apparently some skepticism as to whether the continuous tones could be preserved in the actor's face as the image went through all the compositing stages. The test consisted of shots of a Frisbee champion throwing a Frisbee since one of the weapons used in the electronic realm was to be a disc thrown like a Frisbee. The actor was dressed in a white costume with black lines on it and was photographed in a white limbo using both VistaVision and an anamorphic 35mm format. The footage was taken through the necessary duplicating and compositing stages to add glowing color to various elements and the results were successful enough to persuade Disney to finance the picture.

The script was rewritten and re-storyboarded with input from Disney, and three topflight designers were engaged

Continued on Page 813



(ABOVE) Preliminary costume sketches for Flynn, Sark and Yori by Moebius. (BELOW) A pre-production painting by Peter Lloyd depicting a video game as experienced by the programs for whom it is a mortal combat.



Backlit Effects and Animation For

TRON

"If I had said a year and a half ago that we were going to need 85 people working on the lot, that we'd have to bring in six trailers to create additional office space, that we were going to be sending massive amounts of material to Taiwan for ink and paint, and that we'd need 13 animation stands scattered all over town; they'd have put me in a straight jacket." Harrison Ellenshaw, associate producer on TRON, is commenting on the difficulty of anticipating the amount of post-production work required to execute the backlit effects and animation which give TRON its unique look. The principal reasons for this were, first of all, that no one had ever tried to do a feature in this way and, secondly, that the basic technique involved struck everyone as an ingen-

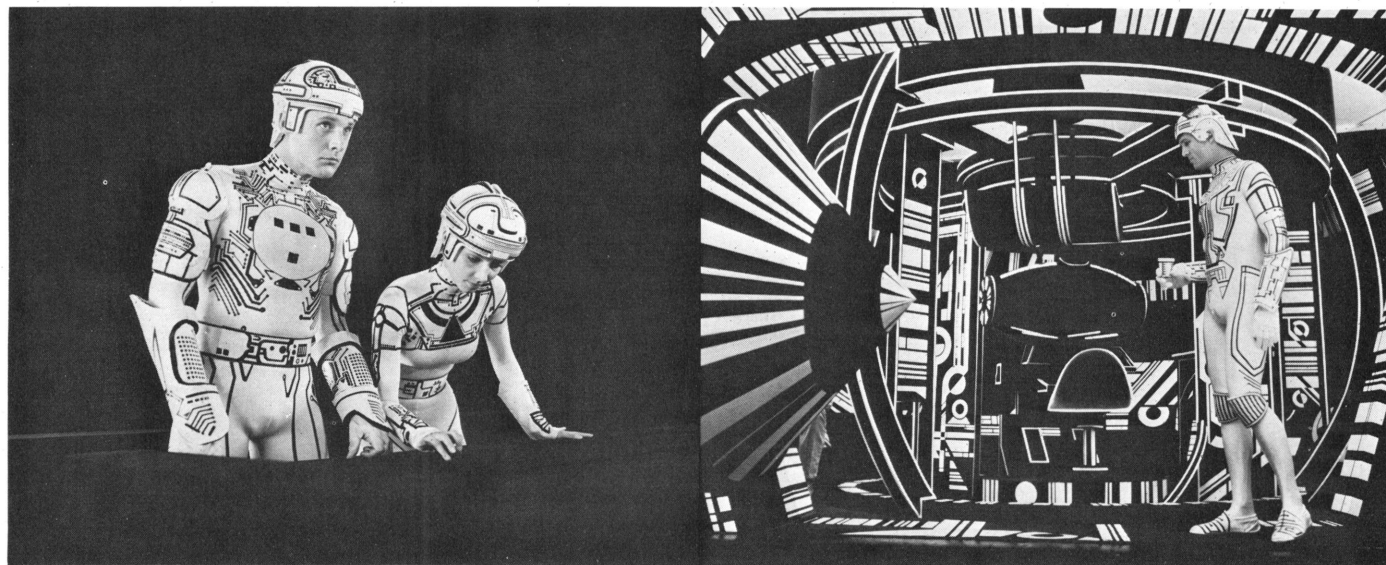
iously simple way to create the effect of an electronic reality. All you had to do was shoot the scenes in black-and-white, enlarge the frames onto Kodaliths which could be put on an animation stand and then add the colors and effects with the back light techniques used so successfully on commercials.

About two-thirds of TRON takes place in a new dimension of reality, a world in which computer programs are humanlike characters and in which physical reality is simulated by electronic energy. Obviously a movie set in such a realm must have a distinctive look if it is to be at all convincing for an audience. At the same time the story is built around characters with whom the audience must sympathize, so the look of these characters could not be too

alien or weird. The solution which director Steven Lisberger adopted was to combine live action photography of actors with computer simulated or painted backgrounds and to use back light to create glowing and pulsating colors. The electronic look of the environment and the characters is achieved by the use of glowing "vector lines" and through the overall quality of the backlit color effects.

Back light as opposed to top light on an animation stand can produce a much more intense light effect on film. When it is used with diffusion materials it creates a look which is not possible with top light and which must be reflected by the art work rather than being transmitted through it directly to the camera. Most notably back light

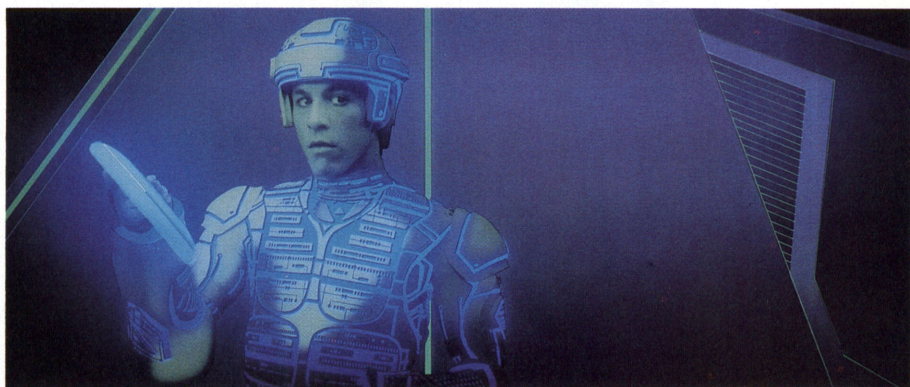
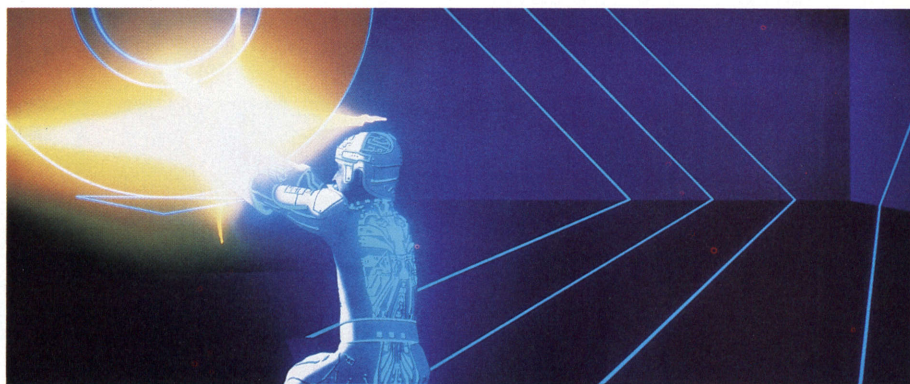
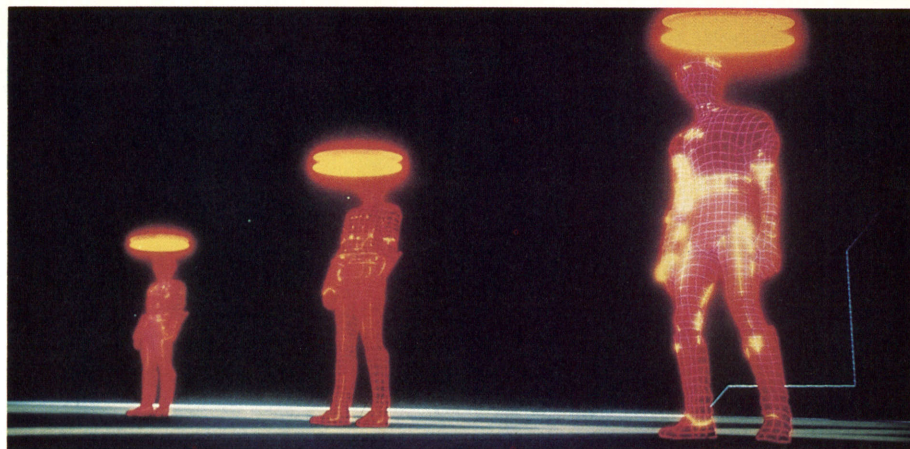
(LEFT) Tron (Bruce Boxleitner) and Yori (Cindy Morgan) navigating the solar sailer as the scene appeared in the live action photography. The interior of the vehicle as well as the buttons Yori is pressing on the control panel were added on the animation stand. (RIGHT) Clu (Jeff Bridges) in his tank. In this case the vector lines for the tank interior were included on the set.



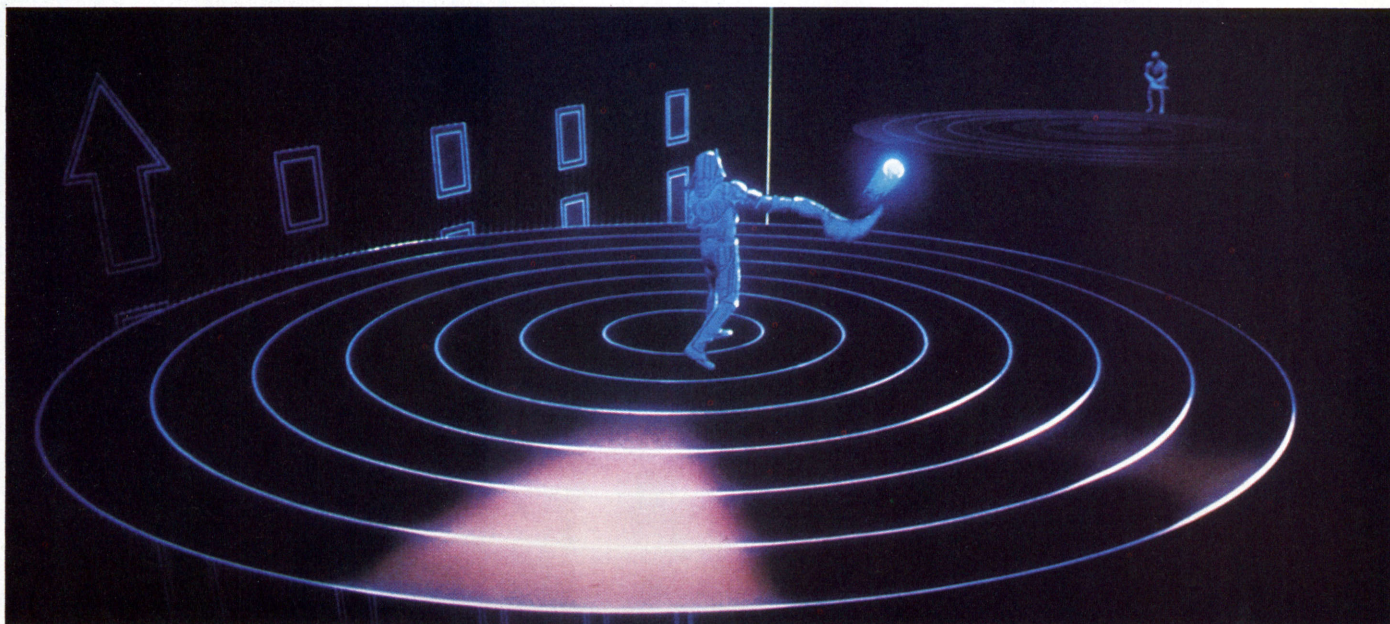
with diffusion can make objects appear to glow in a way that cannot be duplicated with top lit art. One of the things that was discovered in making the sample reel for the NATO convention early in the post-production phase of TRON was the ineffectiveness of painted backgrounds in comparison to the back lit elements.

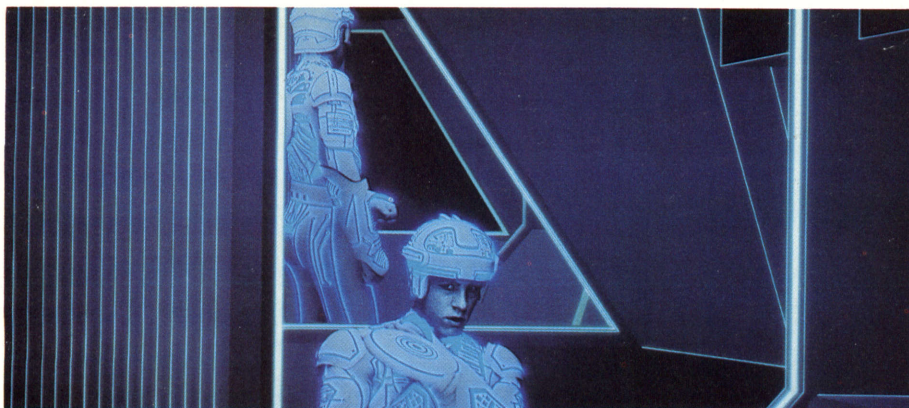
Originally the plan had been to paint background in color and then add backlit elements like the vector lines, but the tests revealed that a painted background just did not have the quality that the environments needed. The paint created a feeling of solidity and texture which was inappropriate for an electronic world where the walls are made of light or energy. As a result the decision was made to do all the back-grounds in black-and-white, transfer them to Kodaliths, and add the color by filters with back light. Similarly the earliest plan for the live action photography was to add the color by painting the back of the Kodaliths in the same way a conventional animation cel is painted, but it was realized that back light and filters would create a much more appropriate look.

Back light has two other advantages over top light which proved useful for TRON. First of all it is possible to vary the intensity of a color or even to change the color within a shot using the same piece of art. Secondly it is possible to reshoot entire sequences in a completely different color scheme without having to redo any of the art work. In ap-



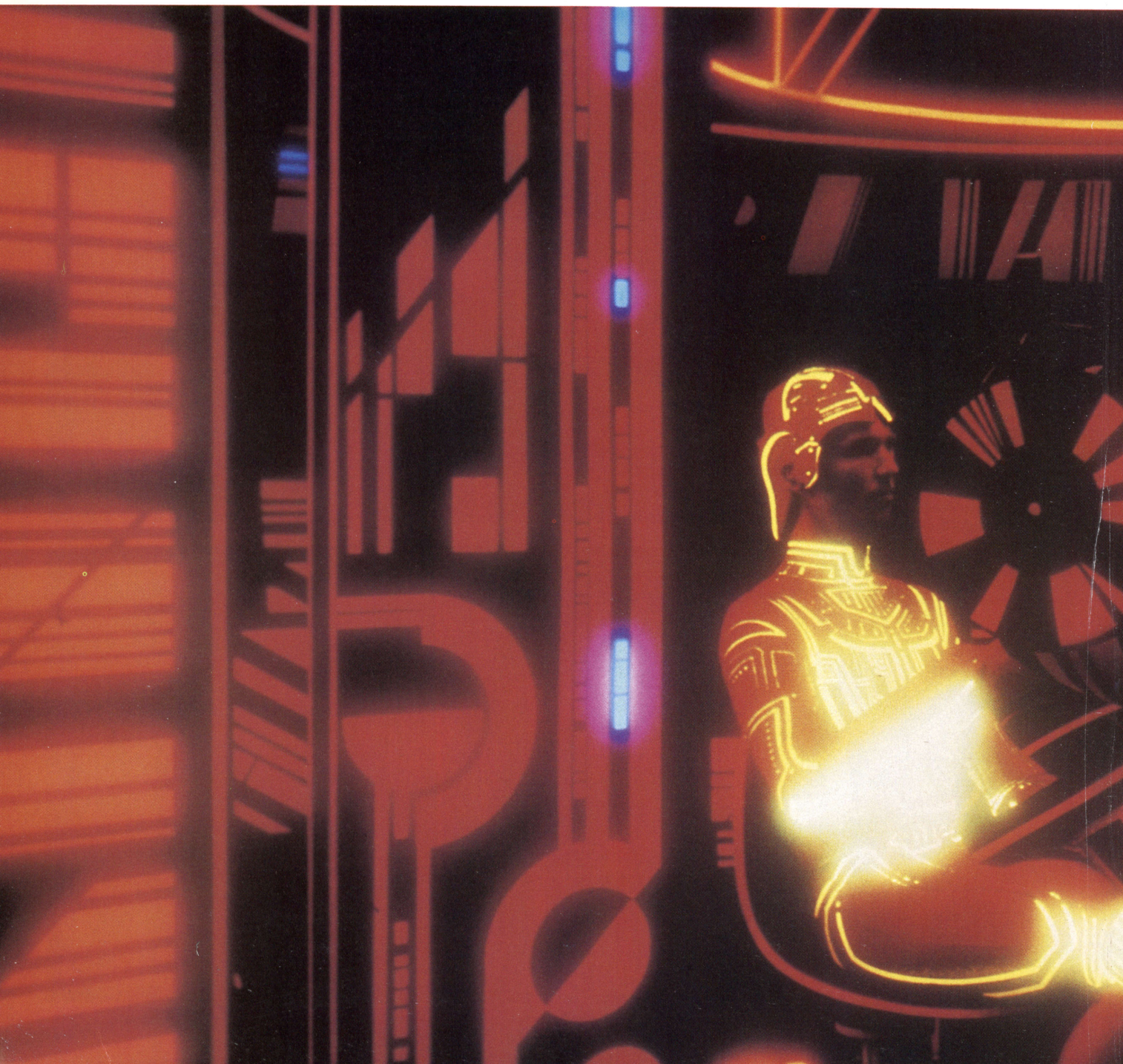
Colors, glowing circuitry or vector lines and interactive light effects were all added to black-and-white live action photography by means of backlit animation techniques.





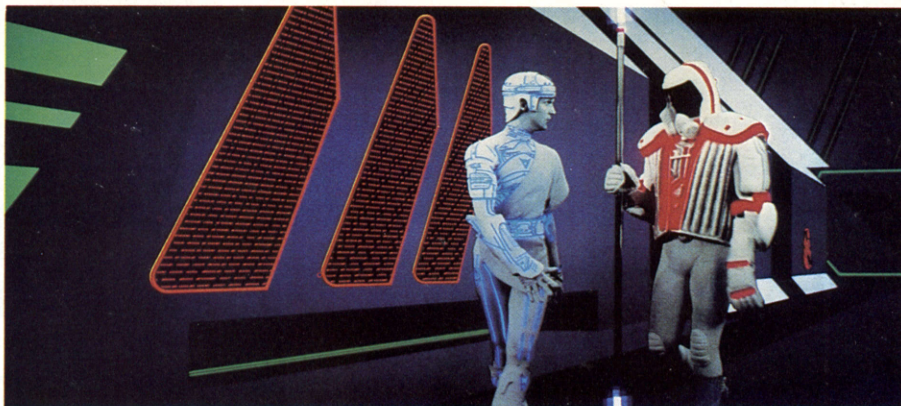
(ABOVE) Tron (Boxleitner) and Ram (Dan Shor) in their holding cell where they wait to be summoned for their next game. (BELOW) Clu (Bridges) at the controls of his tank. Clu is a program created by Flynn (also played by Bridges) in an attempt to access files which have been appropriated by the MCP. His attempts to penetrate the security of the MCP are depicted as an assault in a video game tank.

proximately three fourths of the shots composited on the animation stand for TRON there is some kind of light change occurring in the shot, and in at least two instances there were major revisions in the color design for the film. The original color scheme called for the good guys to have red and yellow vector lines on their bodies while the bad guys had blue lines. It was assumed that blue was more appropriate for the villains because it was a colder color, and the still photo tests that had been done seemed to bear this out. When the NATO reel was completed, however, it was obvious that characters with blue lines on them were somehow easier to look at than characters

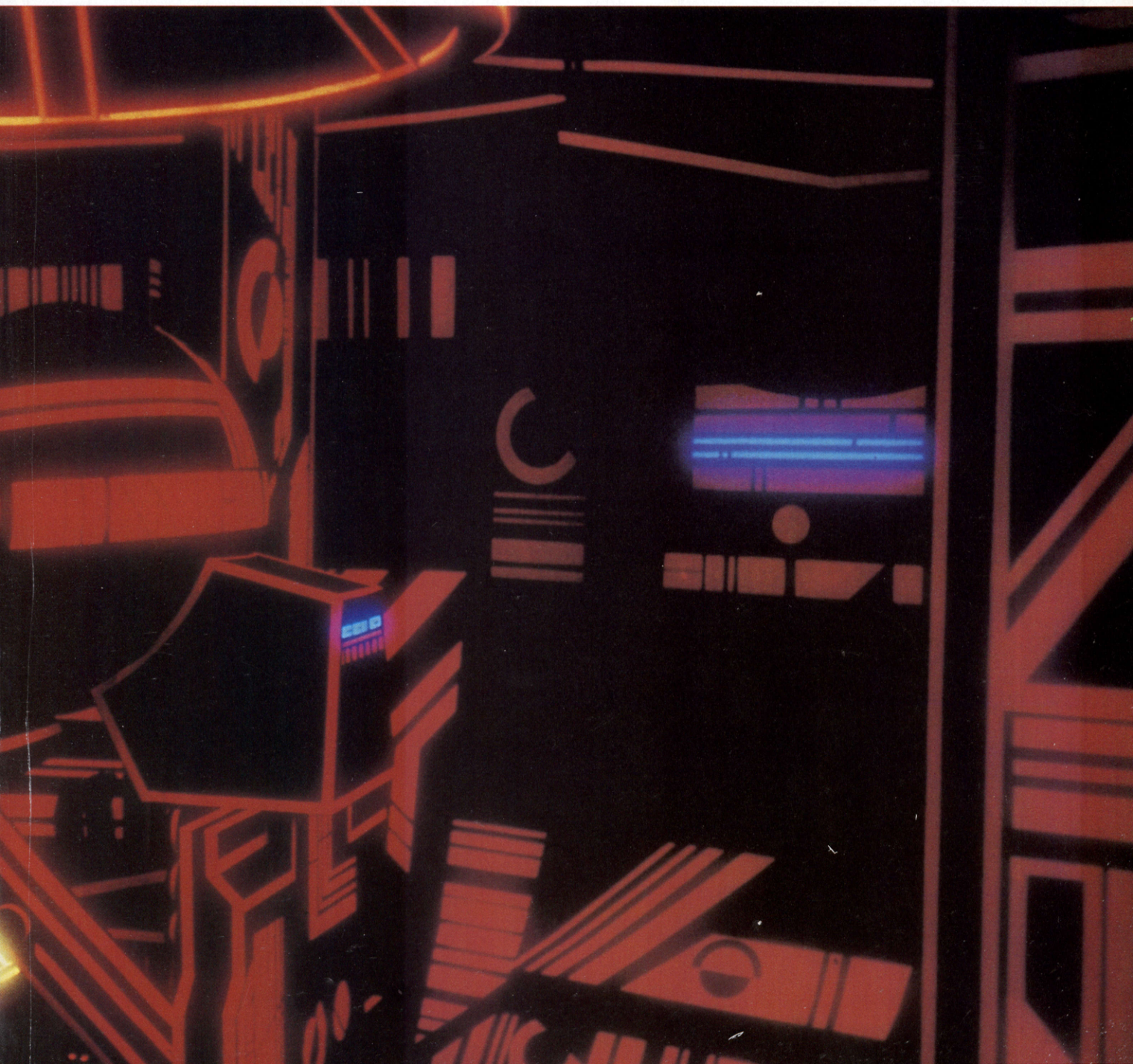


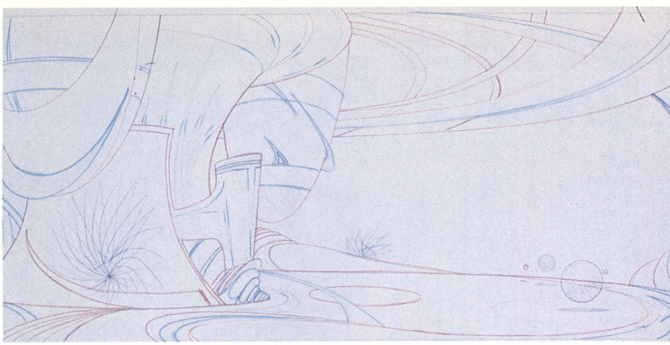
with red or yellow lines. Since this could have an effect on audience involvement with the heroes in the long haul, it seemed necessary to reverse the color scheme. This proved feasible because of the back light approach, even though it meant re-compositing perhaps 10% of the effects footage for the film. All the same elements could be put back onto the stand with different filters on the camera for the passes in which the vector lines were exposed.

The original design of the film also called for the absence of anything close to a natural skin tone for the characters in the electronic world; but as one person describes it, "When we



Flynn (Bridges) being escorted by a guard after he has been digitized by a laser blast and finds himself in the electronic world. Flynn differs from the other characters in the electronic world in that he is a user rather than a program, although the difference is not apparent to anyone until he exercises some of his powers.

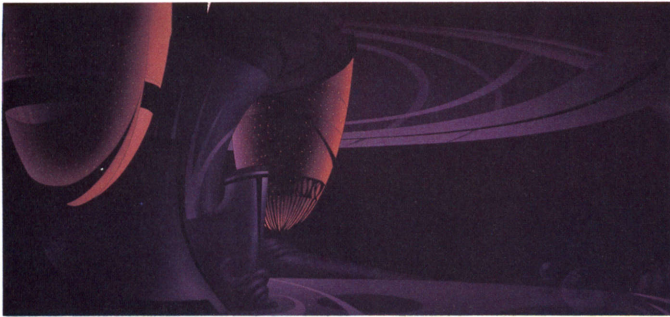




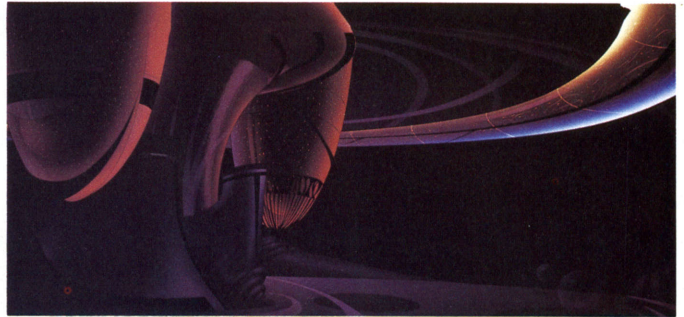
1: Original Peter Lloyd pencil layout of Yori's apartment



2: Painting of Yori's apartment



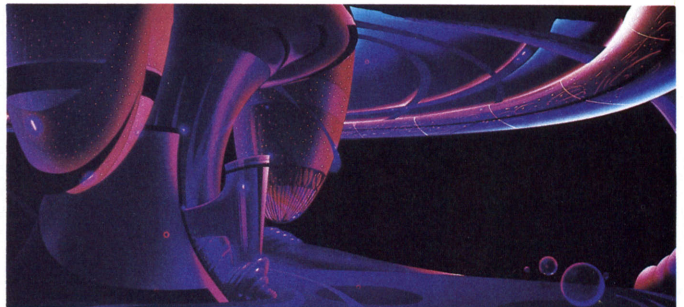
3: Beginning of the matting-in of color



4: Advanced look from #3 featuring more shapes and highlights

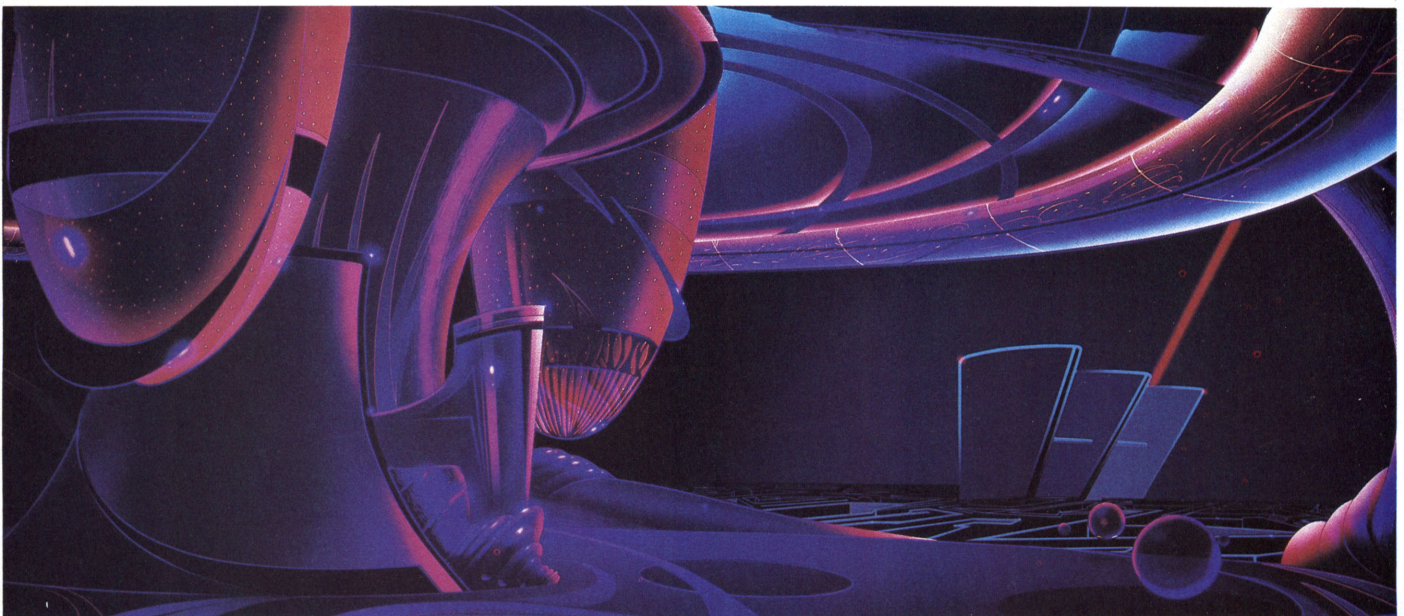


5: Vectors (color lines) added to finished shot



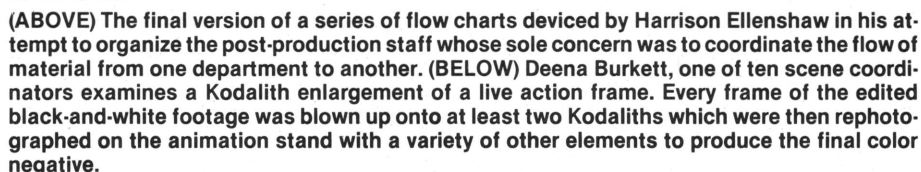
6: Composite without vectors and without the Input/Output Tower.

Steps in the compositing of a background starting with the artist's sketch and culminating in the fully rendered background for Yori's apartment (BELOW). Although this background was used in a scene which was eventually deleted from the final version of the film, it is representative of the work that went into a typical background. The seven steps shown here are actually only a fraction of the stages a background would go through with sometimes as many as forty different elements required to produce the final composite.



The first step in the post-production process after the live action photography had been edited was to enlarge every frame onto 16" x 20" Kodaliths. This was done on a rotoscope camera with a 65mm movement in the camera head. Originally the camera was set up with a VistaVision movement since the plan was to do the live action photography in VistaVision, but since this proved impractical the camera had to be changed to 65mm. Sheets of Kodalith film were punched and laid down by hand one at a time. The pins used for all the animation stand work were Disney pins (as opposed to the more common Acmen pins) with an additional set of pins added towards the outer edges because of the wide screen format. The operator of the rotoscope camera could enlarge a frame about every fifteen seconds once he settled into a working procedure. At first every frame was enlarged directly onto three separate Kodaliths, each of which was processed differently. One was processed with continuous tone chemistry, a second with conventional high contrast chemistry and the third was processed to yield something in between. It was soon realized, however, that the third Kodalith was not essential and that the second could be contact printed from the first without tying up the rotoscope camera; so for the bulk of the film the rotoscope camera was used purely to expose the Kodalith that would be processed in the continuous tone chemistry.

Continued on Page 823



Computer Imagery For TRON

Fifteen minutes of TRON consists of moving images which were generated completely by computer. In addition to these 235 scenes which were printed directly onto a VistaVision negative by the computer and cut into the picture, there are over 200 other scenes in which computer generated backgrounds have been added to live action scenes. In this case the computer printed the background onto a 4 x 5 transparency which was taken enlarged onto a 16 x 20 transparency. This 16 x 20 Ektachrome was used on the animation stand like a matte painting along with the frame blow-ups of the

live action and the other elements in the backlit compositing.

In addition to the aptness of using computer simulation to tell a story set in a computer generated world, computer imagery offers several advantages over the conventional animation or miniature techniques which could have been used to create similar images. The principal advantage is greatly increased flexibility. In a sense computer simulation combines the best features of conventional animation and miniature photography, and then goes each process one better. For example, it is very easy to do perspective

changes with computer imagery which would be extremely difficult with conventional animation and some of which would even be impossible with miniatures. Computer simulation can produce a shot of an aircraft headed towards the camera and then have the camera go through the canopy into the interior of the plane and continue through the inside of the fuselage coming out the tail of the plane to turn around and view the plane as it flies away from the camera. The same shot could include a 360° pan of the environment through which the plane is flying.

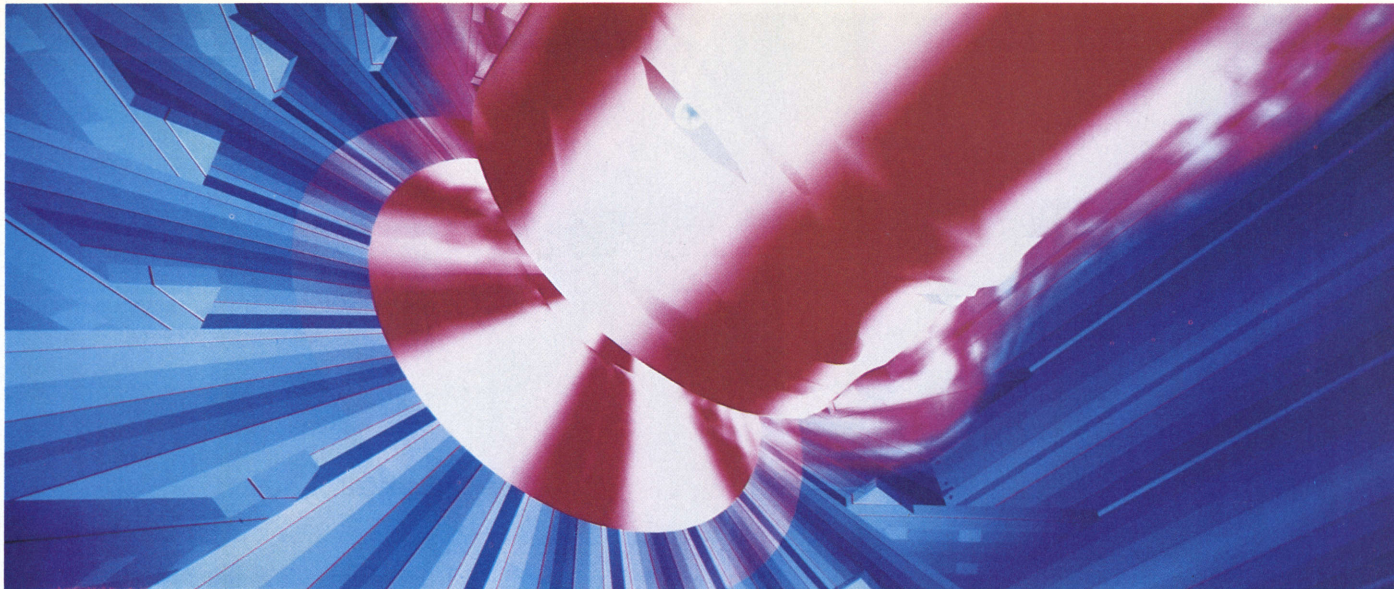
Computer image choreographer Bill Kroyer previews a series of frames on the Chromatics terminal which is linked to the MAGI computer by a telephone line. The terminal was used for previewing pencil tests of computer animation and sample frames of full color computer scenes before the computer images were transferred to film.



Bill Kroyer, one of the animators responsible for the choreography of the computer simulation in TRON along with Jerry Rees, describes a commercial he animated once with conventional techniques only to have the client change his mind when it was completed and say it would be better if the whole 30 second scene could be viewed from a slightly lower angle. This of course meant starting completely from scratch with all the art work, but with computer simulation it would only have required a few seconds to enter the new information about the camera angle into the computer. A revised pencil test could then be viewed immediately and a completely new full color version could probably be ready the next day.

Similarly, the size, shape, color and texture of objects and backgrounds can be easily altered at any stage of the game with computer simulation. It is as though an entire miniature set could be built and then completely re-built a few minutes before it was scheduled to be shot or perhaps altered substantially for the second take.

Lighting effects can be achieved with computer simulation which would

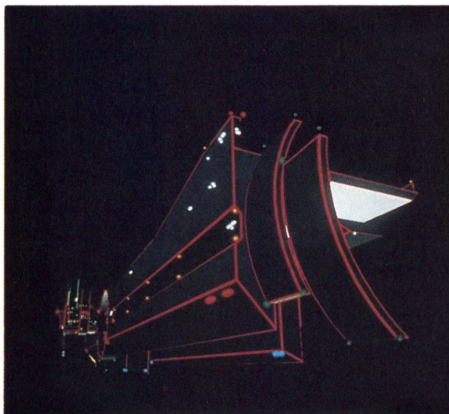
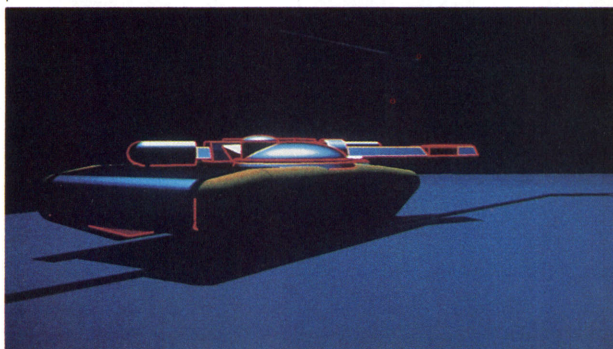


be impossible or extremely difficult with either animation or miniature work. Things that would require prohibitive amounts of airbrushing in conventional animation are the norm for computer simulation, and highly reflective surfaces which create nightmares in miniature photography are easily handled by the computer. As Kroyer puts it there was nothing done with the computers on TRON that could not have been done with conventional animation given \$45 million and 100 years.

In order to understand the techniques used for the computer imagery on TRON it is necessary to distinguish between two kinds of computer graphics: vector graphics and raster graphics. The difference between the two is basically a matter of how the computer analyzes the image. In vector graphics the computer is thinking in terms of black and white lines while with raster graphics it is thinking in terms of pixels, which are tiny dots of color. Raster graphics can create much more sophisticated images but it tends to be a slower process. Vector graphics were used to create two sequences for TRON, the main title sequence and the transition from the real world to the electronic world (or Flynn's ride as it was dubbed). The rest of the computer simulation in TRON was done with raster graphics.

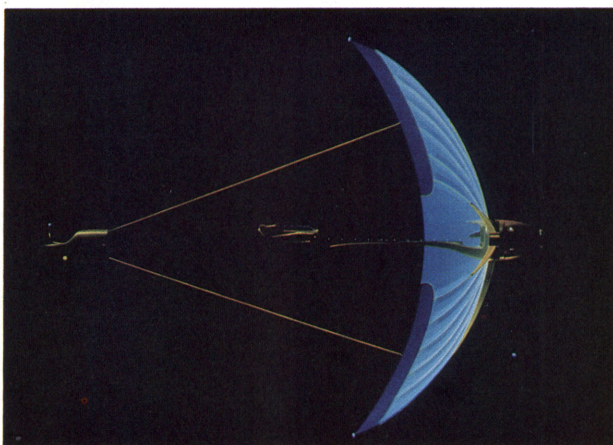
Computer graphics techniques also vary according to how the mathematical models of the objects and environments are constructed in the computer memory. This mathematical model is referred to as the "data base," and there were two different approaches to the creation of a data base in the work

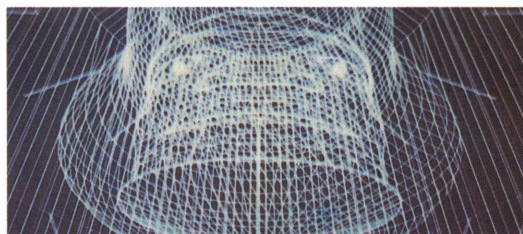
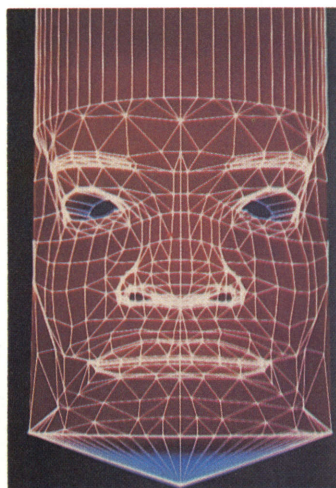
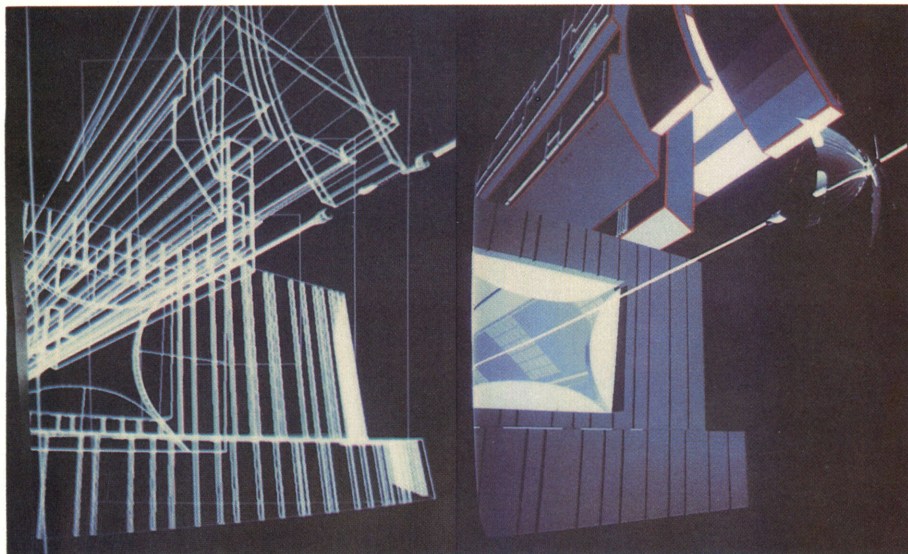
(ABOVE) The MCP with its facial features barely visible as it spins was created by Triple-I digitizing schematic drawings. (RIGHT) The tank was created by MAGI by combining basic geometric shapes rather than digitizing drawings. The MAGI approach offers advantages in the speed with which it can animate the objects it creates, but it has limitations in its ability to generate complex objects.



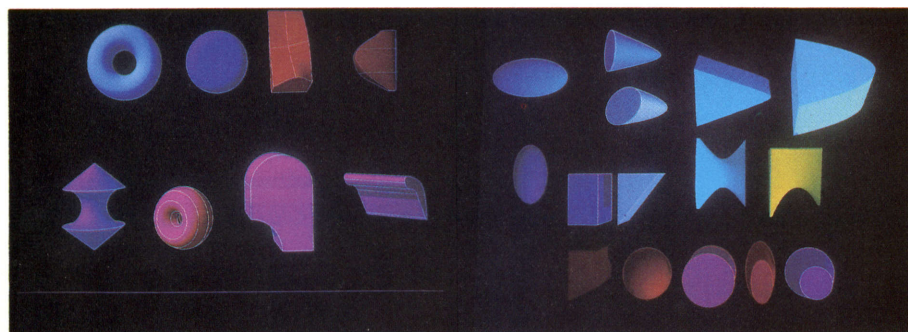
Sark's carrier, an immense battle station from which the MCP's chief henchman commands his pursuit of Flynn and Tron, was created by Triple-I. It is seen here beginning to "de-rez" after Sark has abandoned ship leaving his prisoners to be "de-rezzed" as well. Sound effects contributed greatly to a sense of the scale of the carrier.

The solar sailer with its complex organic shapes and translucent surfaces was one of the most sophisticated objects simulated by Triple-I. As Flynn and Tron progress from the video game realm to the domain of the MCP, the computer simulation becomes increasingly realistic. The solar sailer is a vehicle being developed by a simulation program named Yori which she uses to transport them across the sea of simulation to the MCP.





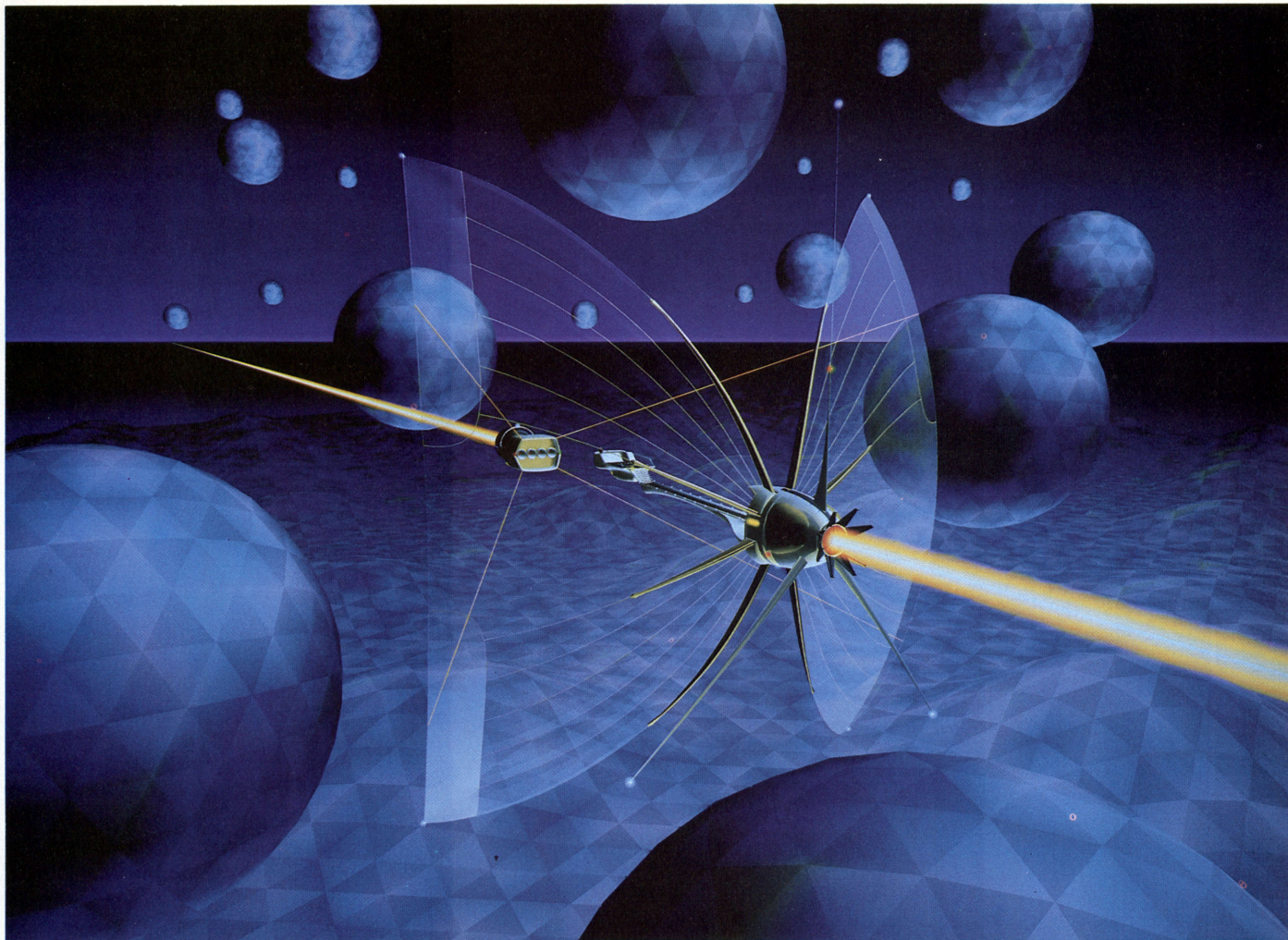
(TOP LEFT) A vector rendering of Sark's carrier looming over the hanger. (TOP RIGHT) A Polaroid of a full color frame of the same scene somewhat modified and with the solar sailer added. (LEFT) The MCP as seen by Sark when he is communicating with it. (ABOVE) A vector rendering of the MCP representing an 85° field of view for the computer eye point. (BELOW LEFT & RIGHT) A sampler of the basic geometric shapes used in the construction of data bases for objects in the MAGI computer. (BOTTOM) Canyons in a landscape simulated by Triple-I.



done for TRON. Each approach has its own advantages and limitations, and one of the decisions that had to be made early on was which approach was best suited to which sequences. The approach used by Mathematical Applications Group Inc. (MAGI) is one which analyzes objects in terms of a set of basic geometric shapes. The data base for the light cycle, for example, was created by describing the light cycle to the computer in terms of spheres, cylinders, etc. having certain spatial relationships to each other. The other method of creating the data base, which was used by Information International Inc. (Triple I), is to "digitize" the object by entering x, y, and z coordinates into the computer using a schematic drawing or blueprint and an electronic encoding table. The drawing is put on the table and points are specified by pressing a button on a crosshair device positioned on the drawing.

MAGI created 8 minutes of computer simulation for TRON. While their method of creating the data base for an object had limitations in terms of the design of the objects they could handle efficiently, the kind of data base it created lent itself more easily to complex moves. Triple I, who did 6½ minutes of footage plus the backgrounds composed with the live action, was able to handle much more complex and organic shapes. The system at Triple I was capable of doing more, but the system at MAGI was faster at doing the kinds of things it did. At the outset Richard Taylor, computer effects supervisor on TRON, analyzed the script and realized that MAGI was best prepared to handle the sequences in the video game domain during the first portion of Flynn's adventures and that Triple I was best suited for the sequences as Flynn journeys across the "sea of simulation" towards the domain of the Master Control Program. He felt that it made sense stylistically to have the computer simulation become increasingly realistic as Flynn approached the MCP. The creation of a special character called The Bit was assigned to another company, Digital Effects Inc., along with one other sequence at the opening of the film. The vector graphics sequences were done by Robert Abel and Associates.

Taylor and director Steven Lisberger had selected these companies from the handful of computer graphics companies capable of meeting the standards required for images to be projected on a theater screen. They all work with systems having at least 2000 lines of resolution. Triple I has a film record-

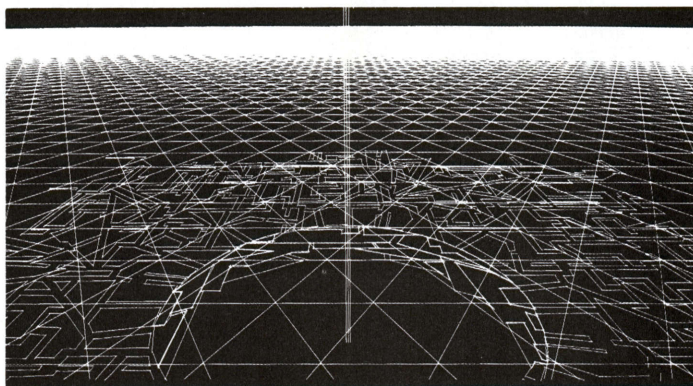


(ABOVE) The solar sailer crossing the sea of simulation on its way to the Master Control Program. (RIGHT) A vector representation and the corresponding final frame from a portion of Flynn's journey to the electronic world. This sequence was created purely with vector graphics at Robert Abel & Associates. The dark patches on the sea of simulation are shadows of vector clouds visible earlier in the shot.

er capable of 4,000 horizontal lines with 6,000 pixels per line, which Taylor estimates exceeds the resolving power of 5247 color negative by 60%. In addition the companies doing computer simulation for TRON had to have programs which were sophisticated enough to eliminate aliasing and rastering (defects often occurring in computer generated images which give objects jagged edges and make them look artificial), and they needed to be able to achieve a variety of other effects which enhance the realism of the image such as "depth clueing" which alters the brightness of an object according to how far away it is from the theoretical camera view point.

The first step in the computer simulation was the creation of the data

Continued on Page 820



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Sound Effects Design and Synthesis for **TRON**

By FRANK SERAFINE

SERAFINE FX STUDIOS

The sound effects design for TRON began with collecting concepts relating to several still frame storyboards, graphics and vector tests. Many major visuals were not seen until the dub was nearly complete. The film came to us already edited in little bits at a time, so that we became very flexible regarding changes. Developing ideas around these visual concepts began our search for sounds that had never been created. In scouting sounds to represent the new areas that we were going to have to venture into, we made several field trips to locations such as Jet Propulsion Laboratories, Pacific Telephone Laboratories, the Sunnyvale computer community (ATARI, APPLE, etc.) and Lockheed Aerospace Center, where we recorded wind tunnels thrusting 100 tons of air per second and psycho-acoustic lab experiments. The research period of collecting sound material was then elevated to the next step of organizing, logging, and categorizing all of the sound effects and production data. With the help of Supervising Sound Editor Gordon Ecker, we devised a system of feeding the mass of information into the computer. Occasional production sessions were scheduled, designing sounds to storyboards spontaneously with synthesizers on the dubbing stage to help the director, production staff, and visual creators grasp what the world of TRON was going to sound like.

Under the direction of Steven Lisberger, and Music/Sound Design

Supervisor Michael Fremer, many sounds were conceptualized before they were created. For instance, the Recos were large metal fighter ships which moved like helicopters. We developed a sound on the Prophet 5 Synthesizer that had the aerobatic quality of a helicopter yet was much bigger and deeper. We combined this

with Tibetan whistles processed through a harmonizer to give a mysterious edge to the sound. The aircraft carrier was quite a different challenge since it floated around the computer world scanning and monitoring all life forms. We had to be careful not to make a cliché of other ships of its kind. We

Continued on Page 830

Frank Serafine at the console in this studio at Lions Gate where he synthesized sound effects for the electronic world of TRON. Using recordings of everything from monkey screams to the Goodyear blimp he combined manipulated organic sounds with totally synthetic sounds to create a unique set of sound effects.



Animation Techniques For

THE SECRET of NIMH

By
RICHARD PATTERSON

THE SECRET OF NIMH is an animated feature from Don Bluth Productions which represents an attempt to resurrect classic animation techniques and combine them with newer techniques not commonly used on animated features. The emphasis throughout is on the use of every available method to increase the illusion of reality and to engage the viewer in the story. Bluth did not want any of the effects to stand out on their own, but he was determined to invest the maximum possible time and effort into the rendering of every scene in order to enhance the story. Techniques used on THE SECRET OF NIMH which have not been used extensively in recent animated features include split exposures to create shadows and translucency, diffusion in conjunction with split exposures to create reflections, color Xerography for the creation of cels and painstaking color orchestration.

Newer techniques include the use of video animation for testing and backlight. The use of multiple exposure techniques is probably the best indication of the time and effort taken with the film. The average number of passes through the camera for a scene in the film was probably four (in comparison with a more common average of two on other contemporary animated features) and some scenes required as many as twelve passes. Similar efforts were

made in every phase of production.

Don Bluth Productions began as a group of Disney animators working nights and weekends in Bluth's garage developing a half-hour animated film called BANJO, THE WOODPILE CAT seen in May on ABC-TV. Eventually the group left Disney, expanded and moved into office space in Studio City. The first camera used for shooting tests was a relatively simple Fax stand of the sort a television station or film school might use, and one of the first steps in the production of THE SECRET OF NIMH was the design and manufacturing of two custom animation stands. Six months were devoted to developing the design specifications for the cameras, and then another fourteen months were spent building and testing the cameras. Two identical camera stands were built by Mechanical Concepts especially for Bluth because there were no animation cameras available commercially that could do everything necessary to shoot THE SECRET OF NIMH, according to Fred Craig, Director of Special Processes for the film.

The main requirements which could not be met by existing cameras were the capability of multiplane photography and a rotating camera head. Some animation stands include a rotating bed which can accomplish the same effect as a rotating camera head (i.e. making an image spin around), but working with a rotating bed is a great deal more awkward since the operator must follow the bed around as it rotates. There were no cameras cap-

able of doing multiplane work anywhere outside of Disney studios. While the camera designed for Bluth is not as large and complex as the multiplane at Disney, it is capable of shooting on two planes and is operated electronically instead of manually.

The camera has an electronically controlled follow focus engineered by Elicon which can be selectively set to follow either plane as the camera moves or to shift gradually from one plane to the other (i.e. it can do a focus pull during a shot). The point of a multiplane camera is that it can create an illusion of depth by combining a foreground and a background, one of which is slightly out of focus. The two planes can also be moved independently of each other to enhance the sense of perspective.

The camera also has an electronically controlled shutter for doing fades and dissolves. It can be set to any length between 5 and 999 frames, and it has different curves for doing fades and for doing dissolves. The nature of a dissolve curve is such that it maintains a matching density on each element and is calibrated slightly differently than the gradations on a straight fade-in or fade-out.

The rest of the controls on the camera are not electronic, but the camera was designed so that it can be hooked up to a computer. Stepped motors are used that can be controlled by a computer, and the camera will probably be completely computerized before the next production. The main benefit of computerization is the repeatability of

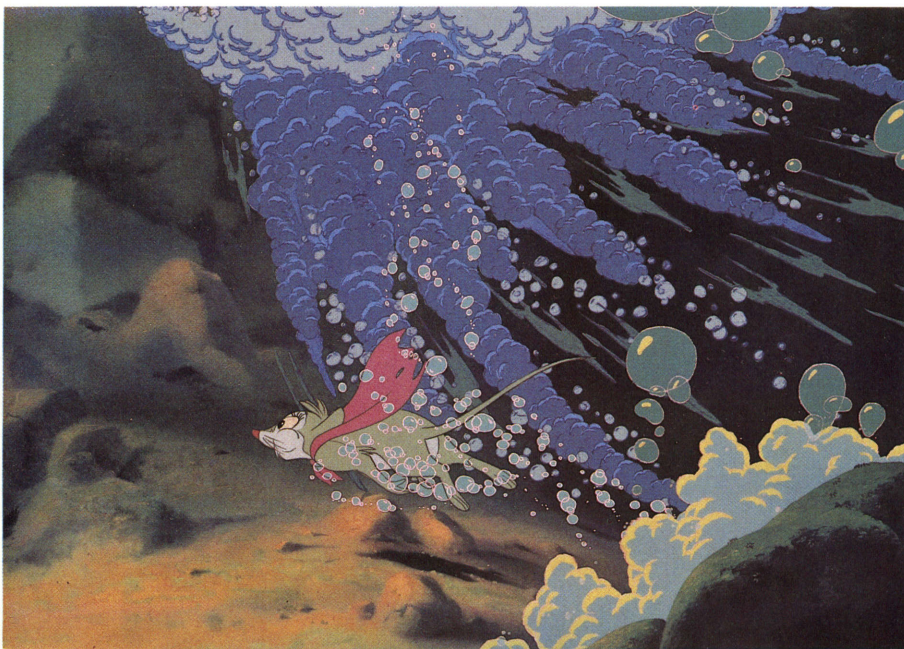
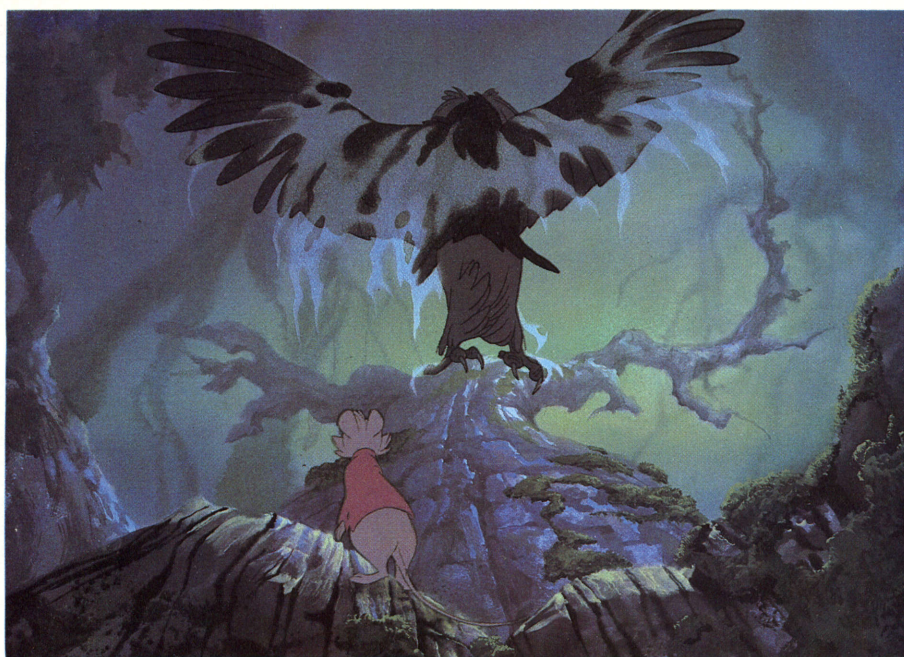


a shot and the reduction of the margin for error in doing multiple passes. It makes the operation of the camera slightly faster, but it does not eliminate the most time consuming aspect of animation photography which is the handling of the cels.

One feature on the camera which does help reduce the time required to lay down the cels, however, is the automatic platen which is activated by foot pedal. Another feature is the use of polarized light since dust or fingerprints on cels do not show up so much with polarized light and less time has to be spent cleaning the cels. Even though polarized light is more or less standard with commercial animation camera services, many of the artists at Bluth were opposed to the technique at the outset. Polarized light was not used at Disney because of the green color shift it can cause. Tests at Bluth Studios convinced everyone that any color shift caused by polarized light could be corrected in the timing at the lab. It did take a while to adapt to the use of polarized light, however, because

(ABOVE) Justin, Captain of the Guard, is introduced to shy Mrs. Brisby by Mr. Ages in the rats' underground domain. Animation for *THE SECRET OF NIMH* represents an attempt to resurrect the best of the classical techniques and combine them with newer methods. (BELOW) Don Bluth, Gary Goldman and John Pomeroy, the producers of *THE SECRET OF NIMH*, are surrounded by some of the original storyboards for the film.





it can cause a blocking up in darker areas of a background. Wedge tests on the initial backgrounds enables the background artists to see how the film responded to their work and they were able to adapt their treatment of shadow areas accordingly.

Another feature which the cameras built for Bluth have that is not found on conventional animation stands is the capability of shooting backlit art in an anamorphic format. Although *THE SECRET OF NIMH* was not shot in an anamorphic format, the next production probably will be; and this was an essential element in the camera design.

STORYBOARDS

The first step in the production after the scripting was the storyboarding. Full color renderings were used for about a third of the film, but time pressures resulted in the use of black-and-white renderings for the rest of the storyboard. Even the black-and-white boards were done in a gray wash rather than a simple line drawing.

A first rough version of the entire film was constructed by shooting the storyboards in continuity and synching them up with the dialogue track. Adjustments were made in the timing for each scene in the storyboard stage until it was felt that the continuity was sufficiently locked down.

VIDEO TESTS

The next step in the production was pose tests done by the animators for each character in a scene. A pose test would consist of a position for every eighth frame. These pose tests would be evaluated with the help of a video animation stand and then a rough test would be done with a line drawing of every other frame of motion. These tests would be further refined using the video animation until the sequence was ready for all of the in-between artwork and a film test would be shot of the pencil drawings on paper.

The video animation was done by means of three Lyon Lamb 1/2" reel-to-reel video recorders modified to record one frame at a time while advancing the tape very slowly. The recorder does not have to back up and re-cue to get a running start each time a frame is re-

(TOP) The majestic Great Owl poises to fly away after advising Mrs. Brisby. (CENTER) A powerful, unseen force surges from the chambers of the rats' leader as Mrs. Brisby huddles against its fury. (BOTTOM) Mrs. Brisby escapes the undertow from a waterfall.

corded. The animator positions his artwork on a platen, adjusts the framing of the video camera by means of its zoom lens while referring to a small monitor, and then presses a button on the tape deck. The recorder will beep when the frame is recorded and he proceeds with the next frame. The entire setup is compact enough to fit on a table top, and simple enough to use that each animator could shoot his own tests of whatever he was working on. It would take perhaps fifteen minutes to shoot a test for a ten second piece, and the results would be available immediately to view and evaluate. Needless to say, this made for a degree of testing that would never have been possible within the same amount of time if the tests had been shot on film. Even with in-house processing it probably would have taken at least five times as long to make a test on film.

MODEL PHOTOGRAPHY

In order to create the most realistic possible motion for some of the objects in the film (as opposed to the characters) high-speed photography of models was used. A model would be shot at 96 frames per second in order to get the maximum possible sharpness for the movement and then every fourth frame would be printed optically and rotoscoped to provide the basis for the art. This was used with great success for the boat, the lantern elevator and the bird cage. An attempt was made to use a model of the tractor, but the model proved to be too small; and it was not possible to get an adequate depth of field in photographing it.

Live action film was also used as a reference in animating the movements of the human characters. There was no actual rotoscoping of human movements but footage was shot and analyzed on a viewer.

FILM PENCIL TEST

Once the pencil drawings were completed, a film test was shot so that the animation could be viewed in sync with the track. The video tests had no sound track with them although a crude comparison could be made by playing the track separately. If the film pencil test was satisfactory, work would begin in preparation for transferring the art to the cels. There were 25 or 30 people working on the pencil drawings, cleaning them up and turning them into a very fine pencil line drawing which would then be Xeroxed onto the cel. The care taken in cleaning up and refin-



Charles Warren operates one of two multiplane cameras built especially for *THE SECRET OF NIMH*. The camera has an electronically controlled follow focus which can execute a focus pull from one plane to the other during the course of a move.

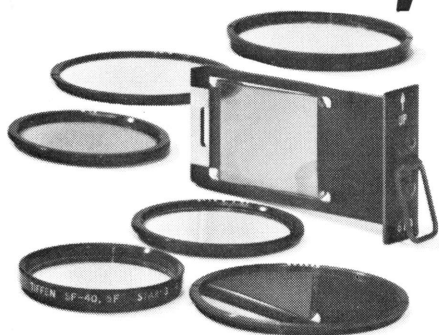
ing the pencil drawings in order to get the finest possible line on the cel is another example of the attempt to duplicate the quality of classic animation with contemporary techniques. In the old days the lines would be inked onto the cels by hand in the appropriate color, but this approach is no longer economically feasible. The ability to Xerox lines onto cels was a major breakthrough in animation technique in 1958, but it can result in relatively crude line drawings if great care is not taken in refining the pencil drawings prior to Xeroxing.

COLOR XEROGRAPHY

Another way in which Bluth has attempted to emulate the classic animation technique is through the use of color toners in the Xerox process. Rather than simply Xerox all the lines onto the

cels as black lines, fourteen different colors of toner were used to create the same effect as was achieved by inking the cels with colored ink. Color Xerography is not a new technique, but it has fallen into disuse, and it was necessary to have the color toners formulated especially for *THE SECRET OF NIMH*. There were four shades of gray and ten hues in addition to the normal black toner used in making the cels. Using a complementary color to define an outline rather than black helps to reduce the viewer's sense of the flatness of the image and increase the sense of reality. For example, flames in a fire are much more convincing if they are outlined in red or yellow than they would be if outlined in black. Similarly, Xeroxing the outline of Jeremy the Crow in a light gray made it much easier to delineate him since a black line would not

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read against the black paint for his body. In some instances the cel would be touched up in order to use more than one color line on a single cel. For example, Jeremy the Crow was Xeroxed in a light gray, but it was necessary to darken the outline for his yellow bill and feet if the lines were to read properly. This was done by rubbing the lines with pastel in the appropriate area. Occasionally when a line needed to be colored rather than just darkened, it would actually be redone with ink as in the case of a character's eye.

COLOR ORCHESTRATION

The color to be used in Xeroxing the pencil drawings was determined in conjunction with all the colors for a scene or character. The degree of attention given to color orchestration for THE SECRET OF NIMH is yet another example of the quality of the production work done on the film. There are more than 600 different colors used in THE SECRET OF NIMH. One character, chemist mouse Mr. Ages, has 26 colors. There were daily meetings of the key staff members to discuss the color choices. Ten or twelve "color models" would be done for a character (i.e. renderings with different color combinations and values) in order to choose the best color scheme. The backgrounds were painted mostly with designer gouache (a re-wettable water color that can be re-worked) and wedge tests were shot for all the backgrounds. The color scheme for a scene was chosen to augment the emotional content of the scene and would vary as the scene progressed through different emotional beats. The best example of this is probably the scene in which Mrs. Brisby and the Shrew try to stop the tractor. It is set at daybreak so that the colors of the background can progress from gray to oranges and reds and then to blues and greens as the emotional content of the scene intensifies and then relaxes.

There are 1078 backgrounds in the film, all of which were tested and then shot in continuity to time so that the entire film could be viewed with the track in the form of just the color backgrounds. This enabled the overall impact of the color scheme to be evaluated and some backgrounds were re-painted as a result.

Once the color scheme for a sequence was set, the pencil drawings were Xeroxed on the front of the cels and the cels were then painted on the back side. They were then turned over to the camera department.

CAMERA DEPARTMENT

By the time a sequence was shot "for real" it had probably been shot in some preliminary form five or six times. If the sequence involved a backlit effect, it was always wedged to determine the best exposure for the effect. At the outset everything was wedged, but as the production progressed it was decided to wedge only the backgrounds and the backlit effects. The photography for the film was done from August through May with a night shift doing the pencil tests and the day shift doing the color. There were over 1000 scenes and only a few dozen had to be re-shot because of some discrepancy in the multiple exposures. An example of a scene that required twelve passes is a shot in a lab which included a background, two characters, their shadows, a Bunsen burner flame, a rope and bubbles rising to the surface of a liquid. Shadows were created by a split exposure using an opaque matte for the shadow area on one exposure. Glowing effects and reflections on a shiny surface were created by superimposing a backlit or a diffused image in a separate pass.

OPTICAL COMPOSITING

In perhaps twelve instances scenes were composited on the optical printer when it was not possible to do all the work on the animation stand. These were generally scenes involving movement on the axis perpendicular to the film plane. For instance the scene in which the rats fall through the vortex was composited optically. The backgrounds were painted about twice the size of other backgrounds and the camera shot a linear truck into the background (i.e. the move did not appear to slow down but seemed as though it would go on forever). The rats were then matted into the moving background optically using mattes shot on the animation stand.

In the course of producing THE SECRET OF NIMH Bluth and his co-producers Gary Goldman and John Pomeroy conducted in-house training sessions in classical animation techniques for new staff members. These sessions were videotaped and may eventually be turned into an educational tool for distribution to schools and libraries. Bluth likes to think of THE SECRET OF NIMH as a film which is ushering in The Second Age of Animation, and he hopes that his studio will be a major factor in the revitalization of the art of animation. ■

to help design the look of the computer world: Moebius, Peter Lloyd, and Syd Mead. Moebius (Jean Giraud), known for his work in Heavy Metal magazine, was primarily responsible for the costume design. Peter Lloyd, a high tech commercial artist, designed environments; and Syd Mead, an internationally renowned industrial designer who had also done work on STAR TREK and BLADE RUNNER, concentrated primarily on the vehicles. He began by designing four vehicles which were to be generated by computer imagery: Sark's aircraft carrier, the light cycle, the tank and the solar sailer.

"Steve wanted recognizable symbols, so what I did was construct the actual article to start off. In the case of the aircraft carrier I drew an aircraft carrier the way they are now, the big Forrestal class carrier, profile, cross section, top view — just to get the sense of it in my mind as an object. And then gradually I started to play with the elements that make it recognizable as an aircraft carrier, which in that case is a flat deck with an offset conning tower kind of construction. I went after the gestalt of why an aircraft carrier looks like that to most people, the in-head memory of the audience, because that's what you have to work with. You are stuck with that. If you violate that past a certain point you aren't working with a real solution. And since Sark's aircraft carrier floated in mid air I thought, 'Well it doesn't need a particular orientation.' So really what I did was put two aircraft carriers edge to edge at the conning tower edge of the flight deck and move the flight deck 90° so that it stuck out rather than up. We had two flat planes at a right angle with a triangular connection on the back underside with the conning tower mass projecting out and floating in this great big round ring."

For the solar sailer Mead used a Spanish galleon as the starting point because he felt the description in the script had a kind of baroque sound to it. "The solar sailer started off as a Spanish galleon to capture the romantic aspects of a ship, so you have the poop deck on the one hand and the forecastle on the other with a sort of loop between. I gradually changed that into an organic fuselage and then took the sail on a shaft coming off the side with something like a tension plate with wires and riggings going back to a wobble so that you could manipulate the sail. Steve liked

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the design but thought the audience might orient the direction of travel with the sail position versus the gondola or the hull. So Moebius then took that particular object over and designed the solar sailer that is in the finished footage." Mead similarly got involved in designing terrain and sets and the logo for the film after his initial work on the vehicles.

Although Mead was aware of the way in which the computer was used to construct its models of the objects, he did not really let that influence his designs too much. He was, in fact, surprised by the way some of his designs meshed with the computer programs. "The tank, which is a very complex object, was relatively cheap to produce in the computer memory whereas the light cycle, which is relatively simple—a round sphere with a blade construction—was very, very difficult and required a lot of compromises to make it look like it does in the finished footage."

Designing objects and environments for hypothetical realm "inside" a computer required some way of indicating that the objects had a different kind of reality than physical objects in the "real" world. In addition to using the backlit effects to give everything an electrical

glow, the principal means of achieving this was to have the objects "rez-up" and "de-rez." The term is derived from "resolve" and refers to the way a computer image is generated. Generally the first step in the creation of a computer image is a form of line drawing displayed on a screen. As the image is fleshed out it is "resolved" into a solid looking image with colors and textures. So objects in the world of TRON appear as a set of vector lines or as a solid object depending on the amount of energy they have. An object can be transported from one place to another by de-rezzing and then rezzing up in the new location. Characters cause the light cycles to rez-up around them by pressing a button on the handlebar. Ironically, the effect of rezzing-up or de-rezzing was not something that could be accomplished with computer imagery if the scene involved live action since there was no practical means of compositing live action with computer generated imagery used for anything other than a simple background. So when the light cycle rezzes up around an actor, the effect is achieved by conventional animation techniques.

Budgeting the production was an extremely difficult task because no one had any experience making a feature in

this manner. As Kushner puts it, budgeting live action photography is a science in comparison to budgeting a production of this sort. Even in retrospect it is difficult to evaluate the original budgets because the nature of the production changed as it progressed. In essence, the further into the production they went, the more opportunities they saw for improving the visual style of the film and the more committed everyone became to taking full advantage of those opportunities. Fears about a directors guild strike and the commitment to a release date also put pressures on the production which increased the costs. Basically, however, no one had any way of anticipating the immensity of the post-production work required for the film. No one could foresee, for example, that it would be necessary to have over 200 people in Taiwan working 12 hours a day 7 days a week for four months inking cels.

The principal photography was originally scheduled for 50 days with no second unit. In the end it took 60 days with the last ten days being devoted to what Lisberger describes as essentially second unit work which he directed. Lisberger recalls, "I had to finish before the supposed directors strike, so we worked

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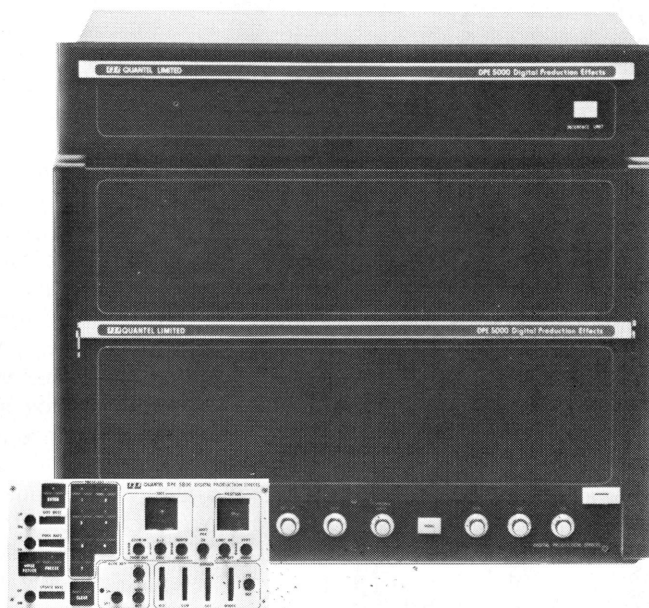
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Saturdays and Sundays very often as well as we worked 14 or 16 hours a day. And then the strike never happened. The pace was pretty awesome. I would get up at 5:30, I was on the set about 7:00, and I rarely got home before 11:00 or 11:30. And I can remember going 14 days in a row and then getting one Sunday off and then going another 14 days in a row. All this on my first feature. If anybody ever tries to do a movie again in 70mm, have them give me a call before they start."

One of the results of the test reel was the conclusion that it was absolutely essential to shoot the black-and-white live action footage on a large format negative because a 35mm anamorphic image just would not hold up well enough in the compositing process. The decision had been made to shoot all of the animation stand work and the computer generated imagery on VistaVision, and it was assumed that the live action photography would be done in VistaVision as well. The test was done in VistaVision but when Director of Photography Bruce Logan got involved with the production he convinced Kushner and Lisberger that they would be better off shooting 65mm. As he describes it, "From my experience on THE INCREDIBLE SHRINKING WOMAN I knew you couldn't shoot a walking, talking motion picture in VistaVision. All the background plates on that picture were VistaVision, and they had dialogue in them so it necessitated having a VistaVision camera blimped, which is a 15 to 20 minute reload. We special ordered 2000-foot rolls which the camera is designed to take, but unfortunately the clutches weren't up to it so we ended up shooting 1000-foot rolls which is five minutes of screen time in the VistaVision format. There's only one blimp available, and it's about 3½ or 4 feet long and 3 feet high and 3 feet wide. It's really an incredible device—all chrome hinges and leather padding. It looks like something out of an S and M shop. So 65mm seemed to be the way to go. I'd had a limited amount of experience just seeing it being used on 2001, so I knew it actually worked even though it was a rackover system and had been on the shelf since RHYAN'S DAUGHTER."

Logan experienced some difficulty in getting a 65mm camera properly tuned so that it didn't chew up film, and it was hard to find an operator who had shot with a rackover viewfinder. The biggest problem however was getting enough light to shoot at the f stop he needed to use. Because every frame of the black-and-white live action footage was going

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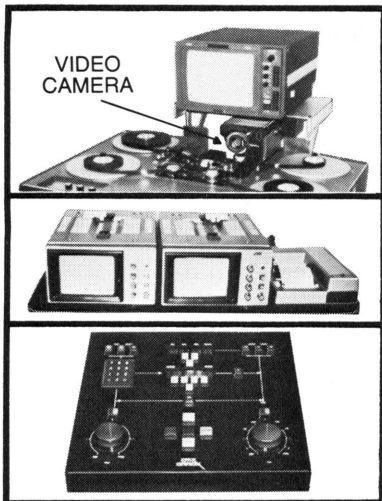
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to be blown up onto Kodaliths and composited with other elements it had to be absolutely sharp. Not only was it necessary to stop down to get the maximum depth of field — a problem which was aggravated by the large negative format — but also it was necessary to cut down the shutter angle in order to prevent blurring of edges during movement. Most of the black-and-white footage was shot with a 90° shutter. As a result Logan's normal key light for the black-and-white scenes shot on the stage was around 1000 footcandles and at times he worked as high as 8,000 footcandles. The post-production processes also required that the black-and-white images be flat and shadowless. The test had been shot with the actor in a white limbo to facilitate delineating the black vector lines on his costume from the background, but Logan quickly realized that it would be totally impractical to light all of the scenes in a white limbo and the decision was made to shoot all of the black-and-white scenes in a black limbo or with white vector lines on a black mock-up of a set. In that way it was not necessary to light everything in the frame. Even so, it required a tremendous amount of current to provide thousands of footcandles of bounce light. At one point Logan was using 12,000 amps, and the City of Burbank called the studio to notify them that they would be shut down if they continued to draw so much current. Fortunately the studio was able to rearrange their load and work things out with the city so that Logan and his crew could resume shooting after about 45 minutes.

For the most part Logan lit the black-and-white scenes by bouncing maxi-brutes off 12 x 12 sheets of white plastic ringed around the set and then when possible adding extra light on the actor's face to give it some modeling. Because the environments were going to be added to the images in post-production, the sets on the stage consisted simply of shapes covered with black velvet or flocked paper. The shapes were constructed in accordance with dimensions which had been fed into the computer to create the background images and served to matte out the actor if he moved behind the object or wall. Logan explains that it took a while to get used to working on this kind of set: "As the movie went on it became more and more apparent that we had all these black sets that gave us the spatial relationships as to how things would be so that we could black the scene out, but whenever we moved the lights around to a new set-up, it was like it was the same

set-up every time. So finally we just built two of these lit areas at each end of the stage and put the sets down with tape on the floor and put the props in there the way they were going to be. We blocked the scene there and then just walked over to the lit area and put it in its correct orientation. For instance, Yori's apartment had seven pieces of furniture in it. We blocked the scene the way we wanted to and then just measured all the distances from the lens to the couch to the side wall and transferred all that into our lit cyc area."

Another approach that evolved during the production was to minimize the set and the set dressing. Originally, a relatively full set was constructed and covered with black so that the actors would be automatically matted out of the shot as they interacted with the set. Often the set pieces made it difficult to keep the light flat enough on the actors' faces. Logan was constantly hiding lights among and even inside the black set pieces in order to remove a shadow. It was felt that in order to facilitate separating the faces from the vector lines and the background, it was necessary to keep the continuous tone portion of the image within a 2½ stop range. If an actor moved near a wall which blocked a significant portion of the light from his face, it would be necessary to hide a light somewhere in the set to fill his face in that position. Eventually they resorted to removing all except the edge of the wall on the assumption that the edge was all that was required to create the matte line. The rest could be blocked out in prepping the Kodaliths to be re-photographed. In some cases, however, it was essential to include the entire set as a reference for the background artists. After every setup Logan would shoot an overexposed frame in which the shapes of the set pieces would be visible and which could serve as a guide for the background artist.

Even with the extreme light levels there were still problems with depth of field. "I hate to say it," confides Lisberger, "but in certain scenes we actually were reduced to putting C-stands up people's shirt backs to make sure that they knew exactly where their marks were! The depth of field was so critical we were talking about half an inch, and that gets a little weird trying to play an intimate scene with a C-stand up your back. We would usually have a camera assistant with a telescopic sight with a cross-hair, and he would tell me through hand signals whether the actor was drifting ahead or behind the mark, and I would then, through hand signals, try to

help the actor regain his mark, all the while giving his Academy Award winning performance."

Logan's job was complicated by the fact that he was not able to see a composited shot until after the completion of principal photography. He didn't even see any of the black-and-white footage he was shooting for the first three weeks. Since shooting 65mm Double-X is not exactly an everyday occurrence in Hollywood, Hal Mann Laboratory had to install special equipment to handle the footage, and the processing system was not completely perfected until three weeks into production. Once the footage began to be processed it was possible to make wedge tests, but even with wedge tests it was difficult to be certain about how critical the light levels and depth of field were. To some extent Logan found himself relying on Lisberger's experience as an animator to decide whether, for example, it was necessary to use a 45° shutter angle to insure clean edges in a particular shot.

Sometimes when he would have to double the light level to shoot with a 45° shutter instead of a 90° shutter, Logan might have thought that Lisberger was being overly concerned with the possi-

bility that some portion of the image might smear and not reproduce properly on the Kodalith. In retrospect, however, he concedes that Lisberger was right and thinks that it might have even been advisable to use a 22½° shutter angle for shots involving very fast movement. The actors wore white costumes with black lines on them that needed to reproduce cleanly in order to add the glowing vector lines. With rapid movement the black lines would tend to smear and register as gray instead of black, and if the gray were above a certain density on the negative, it would not be picked up in the Kodalith. The net result would be that the vector line would simply disappear during the motion.

On the other hand Logan concluded that they may have been overly conservative in their concerns about depth of field and the latitude of the continuous tone portions of the images. "We did these two sequences in the movie — the reco head and the interior of the tank — in which we actually found out that a lot of our fears were just out the window. Admittedly they were very confined circumstances, but the light actually fell off towards the vector line exposure and

things were out of focus and yet they turned out to be some of the most spectacular stuff in the movie."

The first stop in post-production was the assembly of a sample reel to be shown at a National Association of Theater Owners (NATO) convention. This two minute reel, which took about six weeks to produce, served as a trial run for the procedures to be used in the post-production work, and it was a real eye-opener. Associate producer Harrison Ellenshaw described the impact of the NATO reel: "After NATO I sat down and figured out that all the elements required for the backlit compositing work if stacked five feet high would extend 58 feet — and that's short ways. That really hit me hard. Other people said, 'Well, we knew that.' Maybe I was a little naive up until that point, but I finally said, 'My heavens, this is big! This is bigger than all of us!' It was like a monster in the closet. There was always this big monster in the closet, only nobody knew really how big it was or how furry and shaggy it was. Occasionally somebody would open the door and take a look and say, 'Oh gosh, I think it's big! Anybody want to look?' And we'd say, 'Let's not look yet, let's be sure we're ready for it.'

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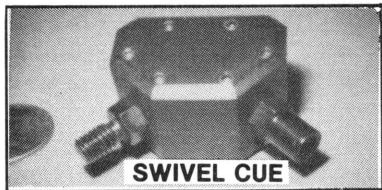
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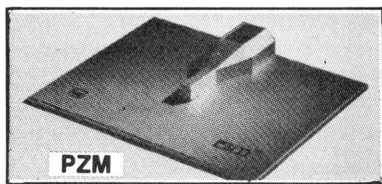
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When we did NATO we still didn't open the door all the way, but we kinda let an arm come out, and we could see it was big."

A little simple arithmetic may help to convey the magnitude of the post-production work on TRON. There were 53 minutes of edited live action black-and-white footage to be composited with backgrounds and effects via backlit animation. At 90 feet per minute and 16 frames per foot, that's 76,320 frames each one of which had to be blown up onto a 16 x 20 Kodalith two times, once for the continuous tone portion of the image and once for the hi-con vector line portion. Each of these Kodaliths had to be accompanied by cels with ink and paint matting to block out some areas and expose other areas. Once you add the elements required for effects animation and additional characters you wind up with between 400,000 and 500,000 elements to go onto the animation stand. The average shot on the animation stand involved 12 or 15 passes and many required 40 or 50. In addition to the backlit animation there were 15 minutes of computer generated footage so that all told there were 68 minutes of effects in TRON. At the peak of post-pro-

duction there were nine people who were doing nothing but managing the flow of material from one department or facility to another, including two unit managers.

Before any of the work could be done on the compositing the live acting footage had to be edited. Because of the cost and expense of the compositing techniques the goal was to fine cut the film as much as possible before adding the backgrounds. Editor Jeff Gourson found himself having to fine cut a movie in which two thirds of the footage consisted of black-and-white shots of actors in a black limbo or temporary shots of the storyboards which he cut in rather than using scene-missing leader. Needless to say he was a little disconcerted when they began cutting negative on the black and white material as soon as he had a reel locked. "I get very nervous when they start cutting negatives that early. I said, 'No, no, no, there's got to be another way of doing this. Rather than cutting up the negative, why don't you guys blow up your frames by the key numbers. That way if something is screwed up we can always go back and extend it.' And they said, 'O.K. That's a good idea.' Well, that lasted for a few

weeks, and I guess they found it was taking too much time to wind the negative down, thread it up, shoot it, take it down and rewind it. So they said they had to cut negative and I said, 'O.K. If you're going to cut negative, give me a couple of feet on each end.' So they said, 'O.K.' Well, the bottom line is that I ended up with a five frame handle on each cut. Supposedly they were going to blow up those five frames, but when it went into all its other stages of background animation, they only did it to the exact cut. They didn't give me anything. I was getting a cut that was exactly the same length as I had in the movie. Then they started finding problems within a shot—maybe one frame with a glitch in it—and they started jump cutting the frame out. Well that made me one frame short, so I suggested to them, 'Why don't you shoot the last frame twice so at least you have an extra frame. If you do have to take one out, you don't have to go back and re-shoot it because you are one frame short.'"

By the time Gourson started receiving completed shots to cut into the workprint, work was well under way on the sound effects and music. He was, in fact, still cutting in completed shots while the film was being mixed. He could occasionally make adjustments to improve the timing of the editing after he received the composited shots, but for the most part he was locked in. If there was a drastic problem the shot would have to be redone, but as a rule things worked out.

The sound track for TRON, like the visuals, had to reflect the fact that the story was taking place in a realm where no one had ever been and computer generated sound effects play an important role in the film. In addition to totally synthesized sounds, the track includes a great deal of processed organic or real sounds. Just as a lot of the visual design is grounded in recognizable objects, many of the sounds in the film were processed versions of what would ordinarily be recognizable sounds. There is also an attempt to maintain a balance in the sound track between synthetic and natural sound effects because it was felt that there is a limit to how much synthesized sound an audience can accept. For instance conventional Foley work was substituted for the synthesized footsteps originally created for the computer reality. Similarly the score by Wendy Carlos is a blend of synthesized and orchestral and even choral music.

Given the requirements of the concept for the sound track, music and sound design supervisor Michael

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Fremer had to find a way to make possible a great deal of experimentation on a relatively limited budget. "I remember a studio executive producer coming up to me and saying, 'Michael, sound is half of this movie.' I said, 'You're right, Tom. So how come by budget is .0000001%?' The budget was really small, but the producer said, 'Look, that's your budget; work with it.' So I had to do whatever I could to get the most out of the money I had. And when I saw I had a transfer budget of \$15,000-\$20,000 just for the labor of transferring to 35mm mag, I said, 'Well, if I could take that money and put it into sound effects, I'd have that much more to work with.' So that's where the concept of doing our sound effects on 16 track synched to video came about, because I wouldn't have to do those transfers. And at that point the Disney transfer department had their hands full with EPCOT and the Disney park in Tokyo and everytime you would order a transfer you'd have to wait days. I didn't want to deal with that. This was the ideal way to get the whole thing in one room and not have to deal with the transfer department. So I had to search around for somebody to do that for me and that's where Frank Serafine came in."

Serafine was set up in a room at Lion's Gate with all manner of sound processing and recording equipment, some of which was his own and some of which was on loan from manufacturers who were interested in seeing their equipment used for this kind of project. In addition a great deal of conventional 35mm sound effects editing was done by WallaWorks under the supervision of Gordon Ecker, Jr., including some fine cutting and adjusting of effects created by Serafine.

Wendy Carols's music was recorded entirely on 16 track and she delivered tapes which could be used for mixing without any need to edit 35mm tracks. Originally the intention was to have her score the entire picture on the synthesizer and then overdub an orchestra where it seemed appropriate, but time pressures necessitated doing it the other way around. An orchestral score was recorded first as protection with the idea that it could be processed to sound synthetic where necessary if time did not permit the full score to be realized on the synthesizer. In order to get a sound which would mesh with the visuals and the sound effects, a 97 piece orchestra was recorded in the Royal

Albert Hall along with the organ there. There was also a second recording session with a forty voice chorus in Royce Hall at U.C.L.A.

Fremer concedes that some of the people involved with the film had apprehensions about having Carlos score the film. "The big worry with hiring her for some people was, 'It's gonna be too avant garde; you're not gonna be able to hum anything coming out of the theater; it could be weird.' Well we wanted 'weird.' We wanted something different. So Wendy was a person who had done orchestral scores, is a synthesizer whiz and just seemed like the perfect person—except that you wanted something you could hum. So I started working with her, and she came up with all these great pieces of music—none of which you could hum. What I found is that she is so brilliant and so inventive that every bar of music had to have six new ideas. So finally I said, 'Look, here's a nice little phrase. This is great! Take this and just make a melody out of it. Don't go on to the next thing, stay with it and expand it.' And she came up with a love theme that is so beautiful, it will get you right there." Fremer pats his chest. "It's great." ■

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Computer Imagery for TRON
Continued from Page 805

base for the objects and environments which had been designed for the computer sequences. Generally to enter a basic design into the computer would take anywhere from one day to a week. Once this initial data base has been created, however, it is a simple matter to alter it. As each part of an object is entered it can be labeled so that later on you can tell the computer to tint the windshield blue instead of green or you can change the shape of the tail fin.

The next step is to choreograph the action for each particular scene. All of the computer image choreography was done by Bill Kroyer and Jerry Rees, both of whom were animators who had never worked with computer images before. They had storyboarded the entire film with Lisberger even before Disney agreed to finance it and they had continued to revise all the storyboards as the script was rewritten. Taylor worked with them on the sequences to be done on the computers suggesting approaches and pointing out what was possible with computer images that might not have occurred to them. Very rough pencil tests had been done for the scenes even before the data bases for the elements were created in the computer. Once the rough pencil tests were satisfactory Kroyer and Rees began doing descriptive storyboards and flow sheets which would tell the computer programmers exactly how the shot should look. They would put together a "scene folder" which contained blueprints for any element that was not already in the computer and detailed descriptions of every move made by the object or the camera and of every change in the color or lighting for the scene. Usually one of them would take the scene folder to the computer company to go over it with them. Bill Kroyer describes the process:

"We would basically go through each folder with them so they would understand exactly what we were shooting for and could ask questions. And it was during that interplay that we really made great progress in planning scene simulation. This is a very new field and we were constantly making adjustments to circumvent some of the limitations of the process or to take advantage of more easily accessible techniques. It would really stimulate us to work with the people at MAGI because they had a real love for entertainment, and in addition to being very

competent technically they were also very enthused artistically. So we would sit down with them and analyze a scene and describe how we wanted to do it, and they might say, 'Gee, if you do this kind of movement, it's going to take us forever to compute that. But we have a program already that will do it this way and if we did it that way we could do this.' And we'd say, 'Yeah, we can do that. We can adjust this, and gee, can you make this glow?' They'd say, 'Not only can we make that glow, but we can also make things fly out of it.' It would be a constant brainstorm session. Practically every scene was like that."

After these adjustments had been made, the scene would be programmed into the computer, creating a data base for the scene. Just as the data base for any given object could be modified, the data base for a scene could be manipulated any number of ways. The first thing the computer company would do was to generate a pencil test, which would be a low resolution vector line representation of the scene which could be played out on a video monitor in real time. At the beginning of the pro-

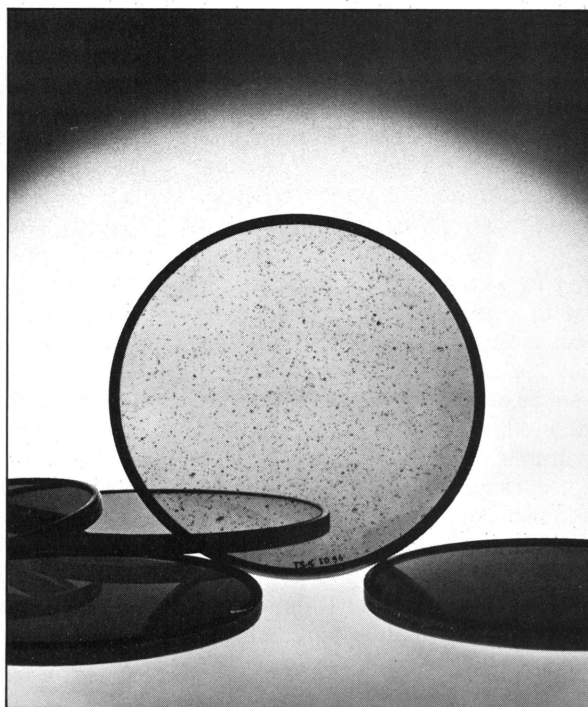
duction MAGI would film these tests and send them to Kroyer and Rees since MAGI was located in New York, and the animators were based at the Disney studios. Later on, however, a Chromatics CGC 7900 color graphic computer was installed in Kroyer and Rees's office and connected to the computer at MAGI via a telephone line. Their terminal was limited to a 1,000 line resolution, but it enabled them to do preliminary checks on color frames and to view pencil tests, which were generally transmitted in the form of an 80 line image. The Chromatics would store up to 1,000 frames of pencil test which could then be played back in real time and speeded up or slowed down. When they viewed the pencil test, they would call the computer company and describe to them any adjustments they might want to make in the action. Generally the initial instructions were so explicit and so well thought out that only minor adjustments were required in the pencil tests. Kroyer estimates that there were only 3 or 4 shots out of the entire 235 that required more than two pencil tests at this stage.

When a pencil test was approved, it would then be printed onto film for the editor to cut into the workprint, and work would begin on color and textures and "lighting" for the scene. A key frame would be selected and the various elements would be programmed into it. One of the keys to the successful application of computer graphics to film work has been the development of a "director's language" for programming which makes it possible to "talk" to the computer in terms of camera angle, focal length, camera movement, etc. As the key frame is being filled in, it can be displayed on the 1000 line monitor and Polaroids can be shot to facilitate evaluation of it.

The program developed by Triple I is capable of creating up to three light sources for any given frame. A light source can be defined as a pinpoint source which casts hard shadows or as a diffuse source casting no shadows. The light sources can be located in the scene or outside the scene and they can even be put in physically impossible places or made invisible, i.e., you can have the effect of a light source

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Once you grasp the notion that raster graphics creates images by analyzing point by point the relationship between a theoretical eye point, a mathematical model of an object and one or more theoretical light sources, it is easy to see how any kind of scene can be created mathematically. If you can define the shape of an object mathematically, you can assign certain light absorbing and reflecting characteristics to every point on its surface. This gives the object color and texture since both of these characteristics are simply functions of how the object reflects light. If you further define the direction from which light is falling on the object and the eye point, you have a mathematical analysis of something corresponding to a scene. This can then be translated into values of red, green and blue for every point in the field of view at the eye point and displayed on a video monitor or recorded onto film.

The film recorder used at Triple I to put the digital image onto film exposes the film by means of a small video tube which is a point line scanner. If you were to watch the tube as the image is playing out, what you would see is a minute point of light moving systematically across the surface of the tube and fluctuating in brightness as it moved. Each frame is exposed in three passes using a red, green or blue filter on each pass. The amount of time required to expose a single frame varies according to the complexity of the image, and one of the things Richard Taylor had to do at the outset of production on TRON was to set a limit for the average time required to expose each frame of film in the computer simulated scenes. The limit he set was five minutes. Some images created by computer graphics for posters or art work might well take 30 minutes or more to play out. Obviously there is no way a film with a production schedule and a release date could handle that kind of complexity. Even at five minutes per frame the printer time required for 15 minutes of film is 1800 hours or 75 days of continuous operation on one printer.

The film recorders were set up to expose the film in a VistaVision format. A contact print would be sent to Kroyer and Rees and assembled into a loop for viewing on a VistaVision projector set

up on one of the stages at Disney. If the scene was approved, it would then be squeezed onto an anamorphic 35mm negative to be cut in with the rest of the film.

For the scenes in which computer simulated backgrounds were composited with live action footage, Taylor devised a method of matching the computer background to the camera angle and field of view of the live action scene. Generally the live action footage would be shot using a set covered with flocked black paper so that the matting of the characters would happen automatically as they interacted with the set. The set was constructed to conform to plans which were also used to create a data base in the computer. The ideal way of connecting the two was to include four "witness points" in the live action scene which could be analyzed by the computer. These witness points could be ping pong balls or small light sources or anything else whose location in the set could be defined for the computer in terms of the data base for the set. Once the computer knew where the witness points were on the set and where they appeared on the screen in the shot, it could deduce the camera position and the focal length of the lens. If these witness points remain visible to the camera during a move, the computer can analyze the camera move and duplicate it on the simulated background.

Unfortunately, the principal photography phase of the production was such that Taylor was not able to implement this witness point system until fairly late, and he had to rely on other methods for matching up the background. Most of the shots to be composited with computer backgrounds were shot with the camera locked off in order to simplify the post-production process. Someone would take notes about the camera position relative to the set as well as the focal length of the lens, and the operator would expose a "hot frame" at the end of every shot. The hot frame was sufficiently overexposed to make the outlines of the black set visible and it included a cube which helped in calculating the vanishing point for that particular camera setup. This hot frame would be enlarged onto a Kodalith just like the portion of the shot that was to be used. The outline of the set as it appeared in the hot frame would be entered into the computer and displayed on a monitor along with a vector line rendering of the data base

for the set. A special set of controls enabled an operator to adjust the parameters for the data base until the appropriate vector lines were precisely superimposed over the outline of the set as it appeared in the shot. This would then tell the computer how the background should be played out for that shot.

One of the advantages of using computer simulated backgrounds instead of matte paintings, is that once the data base for a background is entered into the computer it can generate an entire series of backgrounds for every camera angle involving any portion of that background. Instead of having an artist create a unique matte painting for every angle, the background is "painted" once and the computer generates all the appropriate views of it.

In the sequences done with vector graphics at Robert Abel and Associates the color and the lighting effects were accomplished with filters and multiple passes in the camera, some of which involved bi-pack elements. Abel has a very sophisticated vector graphics system combined with a computer controlled camera which will often do 200 passes or more to create a scene. His use of vector graphics for the TRON sequences was essentially like creating effects with backlit hi-con elements and bi-pack mattes. The computer played out the vector line image onto a 2000 line screen which displayed only black or white and not a gray scale. It could be programmed to display only certain portions of the image for a given pass and was used to generate mattes which could then be bi-packed in the camera for subsequent passes. The time required to display the vector image was generally short enough to permit real time previewing of the shot before it was filmed, but obviously the time required to expose the film fully was much greater. Abel describes his system as it was used on TRON as a vector graphic system which was made to look like a raster graphic system by a lot of tricks. He has further refined and developed his system since his work on TRON to permit the introduction of color and shading information into the image as it is displayed on the video screen.

One of the most striking things about the computer simulation systems used for TRON is the extent to which they are designed to be accessible to film animators or designers and directors. Kroyer and Rees concluded as a result of their work on TRON that computer

simulation is definitely the tool of the future and wondered whether they should start learning to do programming. "The answer we're getting from MAGI," says Kroyer, "is 'Don't bother, because we're improving so fast and the computers are becoming so user-oriented that the average guy will need practically no knowledge at all about the technology to use them.' Recently MAGI installed a new machine that allows them to do all these movements with a joystick in real time, so that if we were to redo TRON today, instead of doing it in 10 months we could do it in two months. Instead of having to plot out every frame, we could just fly a vehicle through a scene in real time. We'd do however many takes it took to get it right or we'd use a good take and just make a few adjustments on it."

The ultimate goal, of course, is real time high resolution color simulation. The closest thing to this in existence (and the source of much of the software and hardware used in computer animation) is the flight simulator made by Evans and Sutherland. A flight simulator is a multi-million dollar interactive color scene simulator which is designed to simulate the experience of

flying an airplane. The pilot sits in a cockpit and sees an airport runway or a landscape or another airplane in exactly the same way he would if he were flying a plane. As he moves the controls the scene changes accordingly and the only difference is that if he crashes it, only his nerves are damaged.

The other tool which is being developed in conjunction with computer simulation is the digital film printer which Taylor predicts will very shortly revolutionize special effects work. The digital film recorder at Triple I is designed to function also as a digital printer. It can digitize a film image so that it can be processed and composited with another film image and then re-recorded onto film in such a way that there is absolutely no degradation of the image. The resolving power of the scanning system is great enough so that the printer can be programmed to recognize the grain pattern in the original images and compensate for it along with the gamma and a host of other things as it plays out the composited image. Needless to say, the digital film printer will be the subject of a future article in *AMERICAN CINEMATOGRAPHER*.

Backlit Effects for TRON Continued from Page 801

from some kind of lathe bed years ago. A second rotoscope camera was acquired from Universal later in the production to help meet deadlines, but it was not as easy to work with as the Disney camera.

The processing of the Kodalith was extremely critical—especially the processing with continuous tone chemistry since Kodalith is designed basically as a high contrast film. Several months were devoted to designing and constructing a processing facility. For the initial tests it had been feasible to send the exposed Kodaliths out to a lab for processing, but once production was actually underway and the rotoscope camera was turning out four Kodaliths a minute, it obviously made no sense to send them out for processing. A processing room was set up adjacent to the rotoscope camera room with two Kreonite processors which had to be adapted to accept the film which was substantially thicker than the paper normally processed in them. An automatic replenishing system was devel-

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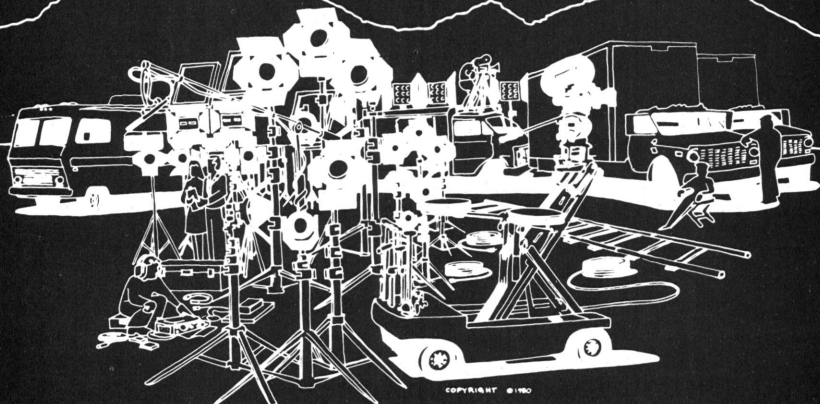
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oped which would be triggered by the film as it entered the processor. The chemicals required for the continuous tone processing are so unstable that they must be mixed immediately prior to use and the processing requires constant replenishment in order to achieve any kind of consistency. Because the individual images would eventually end up as motion picture frames the processing had to be perfectly consistent, otherwise the density variations would show up as brightness changes within a scene.

One indication of the kind of resourcefulness employed in the production of TRON is the way in which inevitable variations in density were handled. In some instances rather than start over again from square one, it was possible to make a virtue of necessity by introducing an effect which would justify the fluctuations in the density of the scene. If for example the vector lines in the background could be made to pulse in a way that corresponded closely enough to the density fluctuations, then they would appear to be causing the fluctuations; and the net result would be a striking special effect which would have been difficult to create deliberately.

The continuous tone Kodalith was contact printed onto another sheet of Kodalith to be processed with hi-con chemistry. The contact printing was done either on a small self-contained contact printer in the processing room or on a larger one in the Disney matte room which has a large light source 18 feet away from the vacuum frame. The larger light source and greater distance result in more parallel light rays for the exposure producing a better contact print.

The Kodaliths for each scene would then be used as the basis for the work done in three different departments: the background department, the effects animation department and the ink and paint department.

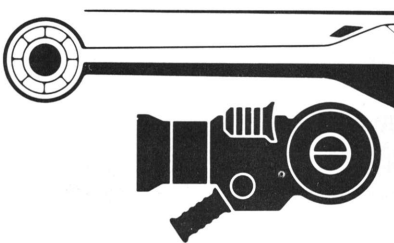
The ink and paint department would create all the mattes necessary to separate the various elements of the live action scenes for the multiple passes on the animation stand, i.e. one matte would have to be made to permit exposing only the faces, another for the bodies, another for the vector lines, etc. The production schedule required that all of this ink and paint work be completed in three and a half months, and although a large percentage of it was done locally, it was necessary to send much of it to Taiwan. This further complicated the logistics of an already for-

midable operation since someone had to figure out how to ship the materials back and forth, how to pack it, how to keep track of it and how to communicate with the ink and paint people in Taiwan. A log sheet was developed which included picture coded lists for checking off the work to be done on a particular scene.

One of the problems encountered in the ink and paint work was how to delineate the boundary between a vector line on a costume and the background. Since the costumes were white with black lines on them and the backgrounds were black, sometimes it was difficult to tell precisely where the vector line on the costume stopped and the background started. At first very elaborate attention was given to this detail, but it quickly became apparent that time would not permit this and Lisberger devised a method of routinizing the work. A grid was created which could be laid over (or under) the Kodak and the inker was told to always have the end of a vector line coincide with a line on the grid if there was any question as to where it should end. The grid consisted of little squares perhaps 1/16" square and the inker could select whichever nearby grid line seemed to be appropriate for each frame. If the end of the line fluctuated from frame to frame, the grid system insured that it did so in a regular fashion and the result was an effect which seemed appropriate for an electronic vector line.

The effects animation department on TRON was supervised by Lee Dyer and consisted of 7 other animators with 12 assistants plus the 4 airbrushers who also worked on the backgrounds. There were 350 scenes involving effects animation totalling approximately 18 minutes of screen time. Some of these effects required 20 or 22 passes in the camera just for the effect alone. Normally this much effects animation on a Disney film would be done in about a year and a half. For instance six people worked for a year and a half to create the fireworks for MARY POPPINS, and a minute and forty seconds of fireworks in LT. ROBIN CRUSOE involved 10 months of 10 hour days. The work for TRON was completed in 6 to 8 months.

There were 16 key effects which recurred many times in the films such as the disc throw or a disc hit. The discs are Frisbee-like weapons which warriors throw at each other in the video game realm. In the live action photography the actor would throw a disc, but in the finished film as soon as it leaves



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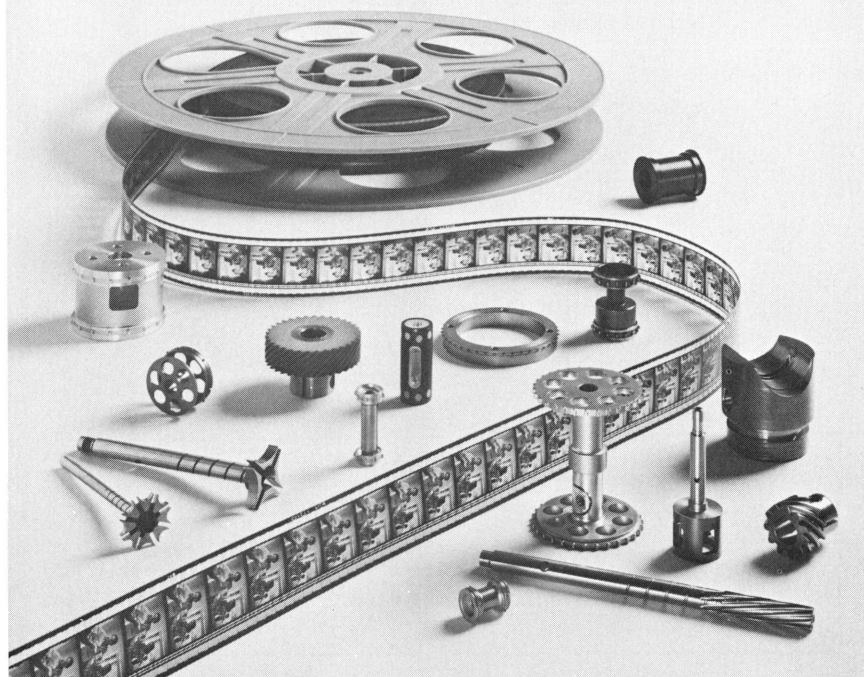
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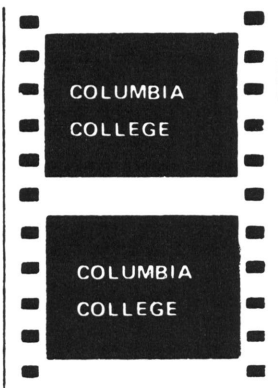
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his hand, the animated effect replaces the live action disc. The disc also involves light effects as it heats up before it is thrown or when it hits someone or is deflected.

Much of the effects animation of TRON was devoted to interactive lighting effects. When a disc heats up and starts to glow, its light must affect the brightness of the elements near it in the scene. This is achieved by creating a series of mattes in the shape of the pool of extra light cast by the disc and then using them to boost the exposure of the part of the scene affected by the light from the disc. The effects animator would put a continuous tone Kodalith for a scene on his light table and do a pencil drawing over it which could then be turned into a hi-con Kodalith to be put on the animation stand with the scene. A black-and-white test would be shot from the hi-con to double check the animation before the elements were turned over to the scene coordinators who wrote up the exposure sheets for the final compositing.

Any scene in which an effect was composited with live action photography was done with this sort of conventional back lit animation. Whenever an object or environment "rezzes up" around a character such as the light cycle or Yori's apartment, every frame has been hand drawn. Practically every cel of effects animation also had some airbrushing involved in it as well. The airbrush work was done in black simply to create soft edges and gradations. The color was added by filters on the animation stand. There was probably more airbrush work done for TRON than has ever been done on a feature film.

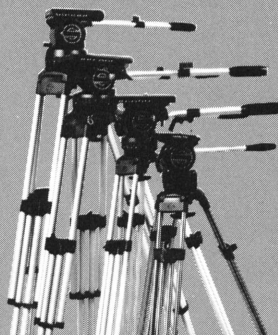
The background department created some 350 backgrounds which were composited with the live action footage on the animation stand. The backgrounds began either as a painting which was done to size and then copied onto a 16 x 20 Ektachrome transparency on a Xerox camera or as a computer simulated scene which was printed out onto a 4 x 5 transparency and then enlarged to the 16 x 20 format. The painted backgrounds were mostly done in black-and-white so that the color could be added on the animation stand. Even with the computer generated backgrounds the background department would create elements to add glowing or pulsating vector lines. Peter Lloyd designed the backgrounds and Marta Russell supervised the compositing of the various background elements. She had about 15 people work-

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ing with her to create various elements and in many cases to composite them before they went to the animation camera. In some instances 30 or 40 elements were used just to create the background, and it was often possible to composite many of these elements into a single color transparency which could then be used for an entire shot on the animation stand.

The first thing the background department would have to do for a background would be to separate the vector lines onto hi-con elements so that they could be exposed and colorized independently on the animation stand. A color scheme for the vector lines had to be set and some indication had to be given as to whether or how the light on the vector lines should pulse during the scene. A sense of perspective was added to the vector lines by airbrushing gradations or introducing neutral density filter elements.

The next step was to add texture and color to walls and other surfaces in the background. Textures were added by using stock graphic arts patterns which could be put onto hi-con film and shot in perspective to match the surface in the background. The task of shooting the bits and pieces of texture in perspective to match was farmed out to G2 Graphic Service which has a camera designed for shooting art work in perspective. Color would be added by specifying filters and exposures for each element in the background and mattes would be created to separate the elements as required. Wedges were shot on key scenes, but in most cases the production schedule was such that it was not possible to shoot a wedge for the background. As was true throughout the post-production of TRON, a certain degree of standardization was required in order to get the film completed and to have some kind of consistency in the look of the film.

The principal people responsible for the consistency of the look of the film were the ten "scene coordinators" to whom all the elements for a given scene would come when it was ready to go to camera. The scene coordinators functioned as a kind of combination designer and animation supervisor. Each one was responsible for a specific set of scenes in the film and would write up the elaborate count sheets for the animation cameraman specifying the colors and exposures for each of the elements in a scene. Since a scene might involve 40 or 50 passes on the camera and most of the color would be added then, the range of possibilities

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was formidable. In addition to an overall color scheme which was developed for the film, Lisberger and the two effects supervisors Harrison Ellenshaw and Richard Taylor devised a detailed set of guidelines for the scene coordinators. Within the parameters set by those guidelines however each scene coordinator was able to make a real contribution to the design of the film.

In order to do the backlit animation stand compositing of the scenes it was necessary to modify not only the animation cameras at Disney but the other cameras used around town as well. First of all none of the cameras had a light box large enough to do backlit photography with 12 1/2 x 20 art. In addition, for the cameras on the Disney lot a computerized exposure control system was developed under the supervision of John Scheele, effects technical supervisor on TRON.

The backlit animation photography for TRON was unique in that it made a great deal of use of precise exposure control for very short exposure times. Most backlit animation done for commercials tends to use longer exposures and there has been very little need for precise exposure control at shutter speeds of less than 1/4 second. For the work on TRON a computer control exposure system was developed which was accurate to 1/10,000th of a second. It was essentially a stepper motor drive applied to the shutter angle as well as the shutter rotation speed. The shutter angle can be set at any one of 2,000 positions between wide open and completely shut. The result of this system was that it was possible to program "light waves" or complex variations in the brightness of any given element in a scene. If a scene coordinator wanted the vector lines in a scene to pulse, there was a booklet containing graphic representations of the light waves which could be generated by the computer. A pattern for the fluctuations could be chosen and the time interval over which it would take place could be specified. The cameras on the Disney lot were computerized so that the operator need only enter a few things via keyboard and the computer would automatically keep track of the frames and set the exposure to achieve the desired pulsation in the light. If a shot requiring this kind of pulsation had to be sent out to a camera stand elsewhere, the computer could print out a list of exposures telling the operator precisely how to expose each frame manually.

Relatively little motion control work

was done on the animation stands in comparison to the norm with backlit animation on commercials. The Disney animation stands were equipped with Cinetron motion control systems, however; and there were some shots which involved moves on the stand.

The filtering was done with glass filters with a range of probably 50 different colors plus an assortment of diffusion filters. Occasionally diffusion material would be placed over the art work on the platen to achieve a special effect as in the Clu torture scene where the character's face begins to break up. One problem which the cameramen encountered with the filters early in the production was that the glass elements in the filters occasionally caused enough diffraction to actually throw an element out of register relative to elements of the scene exposed on a separate pass without the same amount of diffusion. Both Harrison and Tiffen worked closely with the people on TRON to come up with filters that could be used to create the effects they were after without excessive amounts of diffraction. The problem appears to have been aggravated by the fact that the cameras were shooting in the VistaVision format.

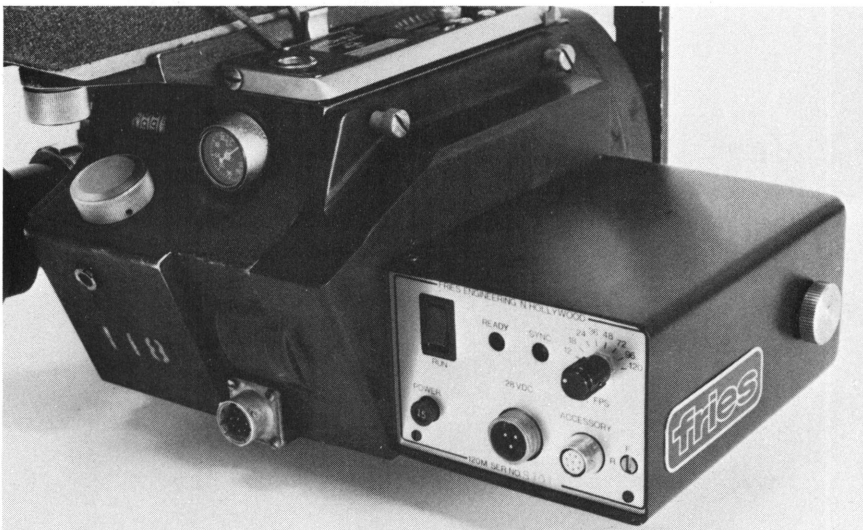
One of the principal advantages of the technique used for TRON is that there was virtually no reliance on optical printing to achieve the effects. Almost every piece of negative which came off the animation stands was a fully composited scene which was ready for negative cutting. It was in the VistaVision format just like the negative for the computer simulation, and the two were cut together to produce the negative from which 70mm or 35mm anamorphic release prints or internegative could be made. It was common to shoot every scene two or three times to iron out all the problems. A small percentage of the shots required more times, the worst being a shot which had to be done 11 or 12 times. Occasionally a shot would be put through the optical printer to reposition it or to achieve an effect that was not feasible on the animation stand. The compositing of the shots in which Sark appears gigantic in relation to TRON, for example, was accomplished with bi-pack mattes in an optical printer.

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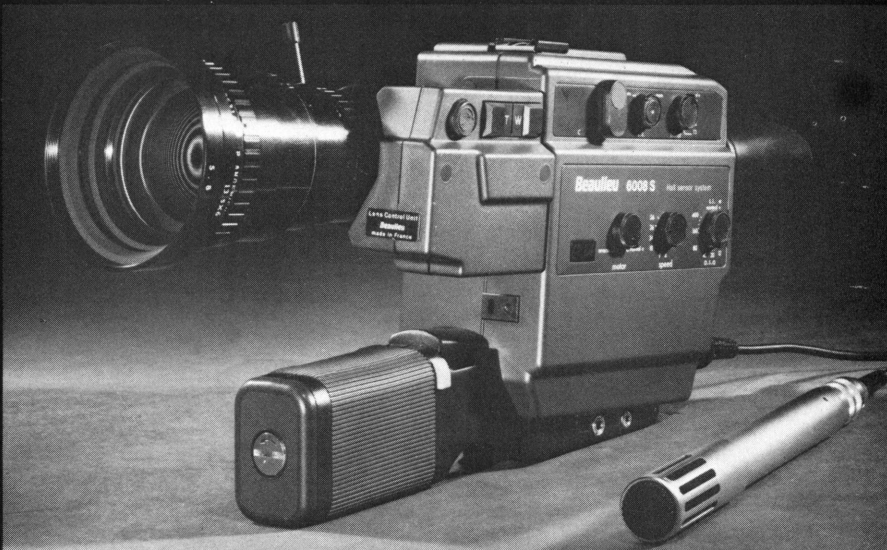


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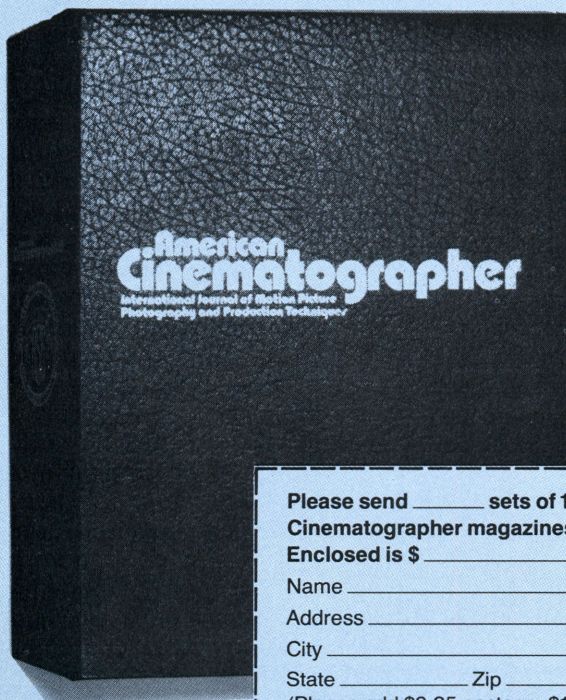


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Sound from TRON
Continued from Page 807

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TRON offered an ideal situation to research and develop the electronic sound assembly process (ESA). The present high quality equipment involved in the video and recording industries has made ESA much more accessible as far as ease of handling and higher sound quality. The process of ESA utilizes the best aspects of the media industries to create a very flexible working method which is adaptable to either film, video, television or multi-media productions.

There are several advantages to this type of assembling process, one being the ability to build your tracks and hear them as they are going to sound on the dubbing stage. This gives the sound creator great flexibility in designing all of the tracks and creating a temporary mix before the tracks are pre-dubbed for final mix. The pure quality of first generation sound presents a noticeable difference in the dynamics and clarity of the high and low end.

Using a Sony V05850, interfaced with a BTX 4600 and a BTX Shadow controller, our multi-track machines (a TEAC 85-10 16-track 1 inch, and AMPEX 16-track 2 inch) were played to the video. The TEAC 1 inch is our audio library which consists of 10 hours of sound effects. We take all of these effects and mix them down to tracks 3 and 4, 7 and 8, 10 and 11, 13 and 14, track 15 is open and 16 is SMPTE time code. The tracks are staggered in order to prevent cross-talk or bleed-through between channels. The AMPEX 2 inch is the master deck which is always slaved to the master video picture. The BTX basically overrides the video so that the BTX Shadow runs the video and the 2 inch AMPEX. Many sounds are then assembled by time code and inserted at the chosen point. We can crawl through the film frame by frame or fly at super high speeds. Once we mark the zero point, we always have the memory to return to that zero point.

The AMPEX 16-track, our second machine is the master reel which eventually goes on stage to be dubbed by Mike Lee and Bob Minkler at Lion's

Gate Sound Stage A. Real time capabilities were not possible before the implementation of this new technology. In creating the sounds for the Recos and Cycles, we actually played the synthesizers to the picture as it was rolling. This gave a "moving" quality to the sounds, as though being controlled like a video game. The light cycles were created using an analog Moog Synthesizer and Sequential Circuit's Prophet 5 Synthesizer. The Prophet 5 uses conventional analog circuitry combined with digital program storage. It has five voices, two oscillators per voice, and forty program capability with cassette interfacing for program storage. All patching is done by internal routing; there are no external wires. Using the pitch wheel of the two synthesizers, we shifted gears as the cycles accelerated throughout the same grid. We combined these with several organic Harley and turbo Honda cycle effects, recorded by harnessing the cyclist with a Stellavox and strapping Crown pressure zone microphones to the saddle bags. This sound helped create the feeling of motion while riding steadily on a cycle at high speeds. The pass-bys and doppler effects were recorded with cross-stereo miking positions with cycles zooming by at speeds of up to 100 mph. All of these sound effects were designed and processed with harmonizers and delays on multi-track, transferred directly to 35mm mag, and edited by the WallaWorks team also located at the Lion's Gate complex.

The organic sound effects were recorded primarily with the Stellavox SP-8 field recorder and Nagra using an assortment of microphones; mainly Electro Voice, Shure, Crown PZM, Audio Technica, AKG and Sennheiser. The Electro Voice RE20 suited our needs for the best for overall good high and low end response and sound accuracy. The techniques used in recording consisted of cross-miking for the broadest stereo image in most cases. Recording with line inputs was commonly used for direct-in (DI) applications such as Techno Walla, traffic-controllers and coin-operated video arcade games, etc.

The home computers directly applied were the Atari 800 and the Apple II Plus. The Atari 800 served as our master computer under the programming supervision of Laurent Basset and Ed Rotberg. Many video game sound effects were created on the Atari 800 utilizing a sound development disk originally applied in creating coin-operated video game sounds. Four separate

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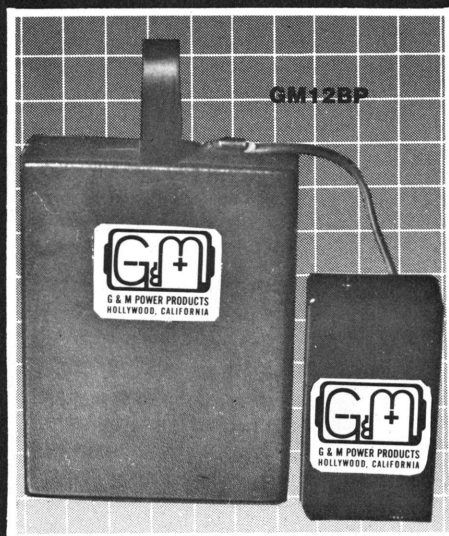
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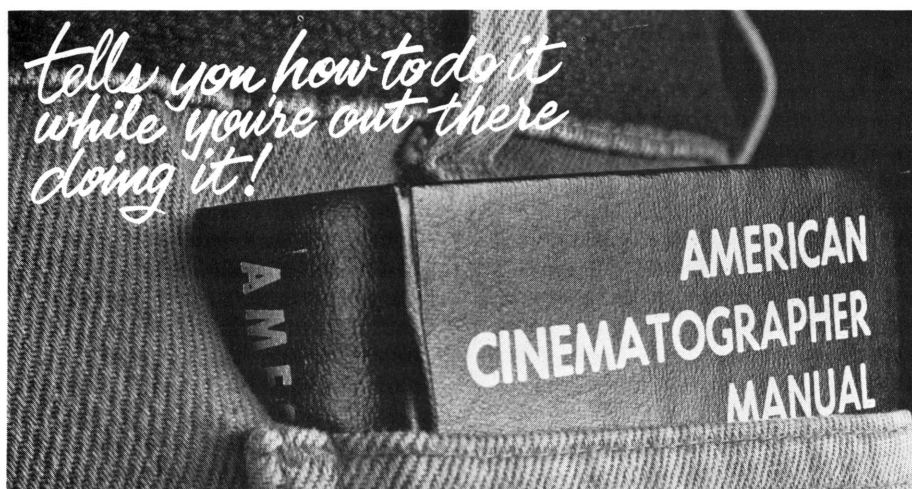
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tracks can be created using the four sound registers available through the "Pokey" sound chip. Amplitude, frequency and velocity can all be controlled via the joystick. The Atari 800 computer, in combination with "Visi-calc" made computerized listings of the track sheets. With this type of reference system, the new technology was used beyond what it was designed to do and was applied in innovative ways. "File Manager 800," a user-customized filing program capable of creating its own character fields, kept track of all the sound effects. The computer sorts by sound, number, category, reel number, track number, clock number, description of sound, and by what this sound relates to visually. Using this system, any effect can be recalled by any of these parameters within 1.5 seconds. For example, if a "rumble" effect was needed, the computer sorted through 500 files and gave everything that was listed under "rumble." The Telegenix projector system displays all of the computer information, including the time code number, on the wall screen. This made it possible to watch the information from both the video and the computer while playing the synthesizer and creating the effects.

In order to effectively create and design the extensive amount of electronic sound needed for TRON, we developed a design station consisting of synchronizers, computers, processors, and electronic tape editing systems. The equipment was organized and approachable, utilizing the sliding and adjustable shelves of the AMCO rack mounting bays. With this type of unit we were able to position the video monitors for eye level and could arrange the equipment in a way that left plenty of leg room. The design station made for low stress and gave us a comfortable environment for creating.

TRON's sound effects are a perfect marriage between organic and synthesized effects. Since TRON takes place inside a video game, everything that has an organic effect is counterparted with an electronic effect. For example, when an explosion hits a wall, we have a video hit plus a big military explosion. This gives the realism of an actual explosion plus the electronic sound to put you in the video game world. You can't make real sounds inside a video game so we've invented some phenomenal sounds for the atmosphere of TRON. For example we took monkey screams and turned them into the deadly disc throw. For the de-rez effect, combinations of sounds were added

together to come up with a composite sound. These were dubbed down on the stage, about eight elements across and five deep.

At the core of our digital synthesis was the Fairlight CMI and programmer Jeff Harris. The Fairlight CMI is a computer called the Quasar M-8, dedicated here solely for musical purposes but which is capable of doing general computing and processing. With its unique screen access, different digital storage "pages" or software programs display the parameters of the controls and patches of the instrument. These pages are labeled as a menu. This approach is quite a bit different from the patch cords and knobs of the analog synthesizers; the Fairlight has none at all. All control commands are made on the video screen via a light pen or alpha-numeric keyboard and then stored on a floppy disk (a magnetic storage medium physically similar to a "Flexi-disc" sheet audio record). The menu consists of sound analysis, harmonic amplitude control waveform drawing and alteration, keyboard control and composer-editor. The floppy disk system can also function as a sonic notebook or scratchpad much as an audio recorder might. The third part of the Fairlight is an eight voice polyphonic keyboard.

The Fairlight can store hundreds of real sounds of limited duration on the disk for later retrieval and manipulation. Sounds ranging from the London Symphony, to a Telecaster guitar, to dogs barking out "Bette Davis Eyes," can be placed into digital memory. Each note of the keyboard can retrieve a different sound from the memory simultaneously for a veritable barnyard of effects, which means it can also function as an eight output multi-track recorder which can then be looped for indefinite sustain.

The method by which an organic or real sound is stored is sometimes referred to as digitizing. A voltage form of the signal is processed through an analog-to-digital converter into numerical form. The Fairlight allows the stored signal to be analyzed and displayed on the CRT screen, and once the parameters of the sound are defined, the light pen can be used to modify and cross-fade the sound with others to create entirely new sounds.

Time is not a consideration at all. We can invent on the spot and get to the material within seconds. The Burtoia chimes were loaded on the Fairlight and then went directly on to the tape and used as the light bars that sur-

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round Sark, enveloping him in the MCP Chamber. The Fairlight has a one second sampling time so we put it into the machine and delay it twenty times. I was going to play it manually but instead, we just let the delay take over. There is no wading through ¼ inch tapes looking for the proper effect, no waiting until the next day to get it transferred on to 35 mag.

The signal processors were most important in the manipulation and massaging of the sound effects. In the digital environment that existed we had the challenge of creating sounds to represent specific sounds displayed on the screen as well as sounds that were off-stage. Our primary role was in creating a whole world of sounds for this unique environment: canyons, distant battles, ecos and carriers floating throughout this endless space that existed. The signal processors allowed us to make the dimensions possible in the sound textures: delays, reverbs, harmonizers, phasers, and flangers were used in maximum extremes and subtleties. The delay units used were Deltalab DL2 Acousticcomputer and Digital Memory Module which gave us up to eight seconds of crystal clean digital repeats. The Maxon Analog Delay Flanger gave great metallic qualities to a lot of the organic textures as well as deep phasing and sweep. The Lexicon 224 Digital Reverberator served as our main ambient processor. Any room-size can be recreated anywhere from a bathroom texture to cathedral hall. The Audio and Design Scamp Modules served well in parametric equalization compressing and expanding of the sound. The Deltalab Harmonic Computer and Lexicon Audio-Time Compressor/Expander are pitch shifting devices and were incredibly handy in accelerating the tanks or shifting the small things to large and vice versa. The monitor system is powered by Apt-Holman amps and pre-amps and the speakers are Eastern Acoustics MS50's. This system is ideal for controlled equalization accuracy and provides exact stereo imaging.

As sound effects become more important in the subtleties and dynamics of creating aural excitement for theater audiences, TRON offered a world of complete creativity in exploring all the possibilities in the newest audio-visual products available.

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G.W.T.W.

Continued from Page 791

components was hydroquinone and since it is difficult to dissolve in cold water, I lit the gas heater and put the tray of water on it to mix the chemicals. It was a small tray so I only used half the normal amount of water, thus making the developer double strength. By the time the chemicals were dissolved the developer was quite hot—over 100 degrees; normal was about 70. Inasmuch as this was only a line-up test that needed developing and it was quite late, I poured the approx 105 degree developer into the developing tank, developed the film for about two minutes and then put it into the fixing bath. The emulsion was ready to run off the film base, but we could still see the exposures. Now came the wonderful shock. All three records (or films) matched the exposures we had selected from the lab developed negatives but not our previously developed hand test film. By accident I had made a wonderful discovery. I could hardly wait to get back to work the next day in order to make a fast fixing bath and some chrome alum hardener to harden the film, to keep the emulsion from becoming too soft to handle. We always "read" the negative when it was wet in order to save time; so, I not only had found a way to match Technicolor's developing, I also was saving better than 15 or 20 minutes for each hand test. When you make a lot of tests on a critical shot that is quite a saving.

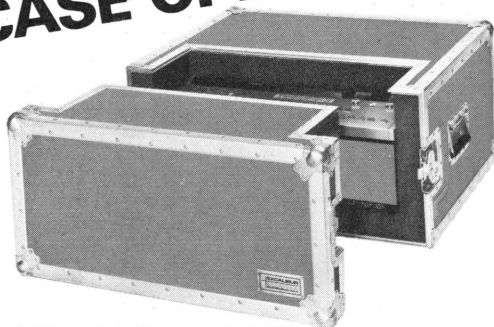
Soon Jack and I were putting the shots through to the lab without any difficulty, for in a few days I had worked out the time and temperature for each film. Mr. Selznick was quite pleased with the way the shots were coming out. He personally would screen our lab tests and would advise Jack what improvement or changes that he desired to be made.

It was about this time that Mr. Selznick had a galley proof of the story GWTW sent to Jack. This was before the book was out. Jack would read the story while I was photographing his matte paintings, and I would read it while he was painting. It was quite obvious that this story would make a wonderful motion picture and that it would need every production trick to create it. As we looked at our meager camera set up and department we knew we would have to start planning for what we would need for working on a picture of this magnitude. This was in the summer of 1936.

About this time I was asked if I would leave Technicolor and join Selznick-International. I did, and I was with the Selznick organization for many years.

Fortunately for us, various things prevented Mr. Selznick from trying for an early starting date. We now knew that we could make matte shots with the new 3-color Technicolor process and that we could work quite fast, thanks to the super-heated and concentrated developer for hand tests. So all our future plans

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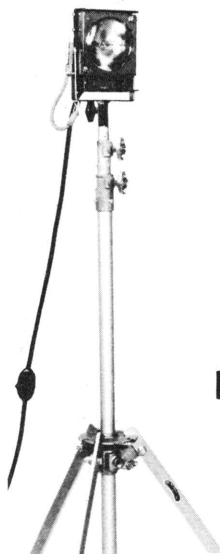
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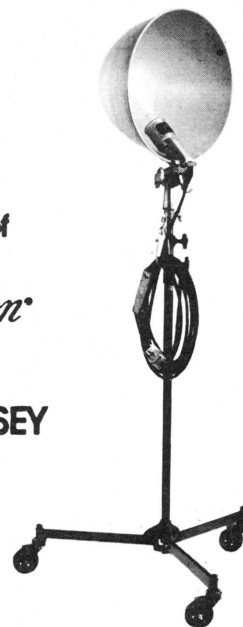
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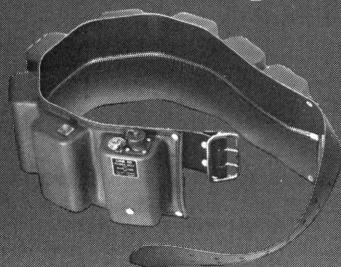
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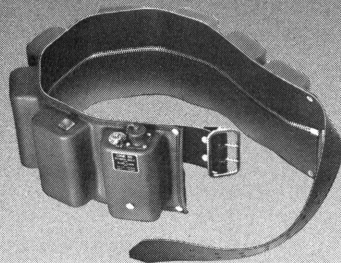


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were for a department that could handle whatever would be required for GWTW. With each color production that we made before the start of GWTW we gained in experience, equipment, and personnel.

On *A STAR IS BORN*, the next picture after *THE GARDEN OF ALLAH*, I designed and had built some good painting easels for photography, some good camera pedestals with movable camera mounts, a better projection set up for layout purposes, and a nodal point panning and tilting tripod head for glass shots (which we used on the sunset shot when Fredric March walks into the ocean in *A STAR IS BORN*). Using one of George Teague's background projectors we also did the first rear projection shot in Technicolor. Jack now had a matte artist, Byron Crabbe, to help with the painting and a little later on another artist, Albert Simpson. Al was an excellent man for matching or blending the painting with the action. Both Al and Byron worked very well together. On *THE PRISONER OF ZENDA* they painted some beautiful matte shots.

Before GWTW started, Selznick produced six pictures, three in color and three in black-and-white. Byron Crabbe died unexpectedly and was replaced by Fitch Fulton, an excellent artist. Al and Fitch also made a great team. Later on Jack Shaw was added as another artist.

Since each artist painted what he did best, each matte shot was generally the product of more than one artist. Al Simpson would do the final matching on the paintings. In those days the part of the painting that was exposed in the original photography was painted black. Very carefully the painting would be blended at the matte line with the original photography.

We had a projector made by George Teague, ASC, for miniature projection which we used for added effects on *TOM SAWYER* and *NOTHING SACRED*. Towards the end of *TOM SAWYER* I improvised an optical printer, using the 3-strip Technicolor camera and using the miniature projector without a lamp-house. Thus with the projector lens I was able to pick up as an aerial image in the projector the image of a painting. The painting could be any distance from the projector and could be the normal size of our regular matte painting. At the same time, if desired, I could run a matte or scene in the projector head. This was in 1937.

Slowly we were getting the necessary tools to do the effects for GWTW. We were proving that these effects could be made so that the production could be designed to utilize them. Both the miniature projection and the aerial image set-ups required lots of light. Technicolor film at that time was quite slow, and it was balanced for daylight photography.

Mr. Robinson of the lamp division of General Electric here and Mr. Farnam of the lamp design division of the Nela Park branch of General Electric were most

helpful. First, after several trips out here, Mr. Farnam developed a 7000-watt projection bulb for us. Then he and Mr. Robinson supplied us with the first reflector flood lights out of Nela Park. He had them made up as 500 watt photo floods. For light for our artists to paint by they provided us with test fluorescent tubes. At that time none of these bulbs or tubes were on the market. Bit by bit we were getting ready for the time when GWTW would start.

We needed more space in which to work. Al Simpson and I talked over many plans—he for the art department section and I for the photographic section. These plans met with Jack's approval; so during a slack production period, and at Mr. Ray Klune's suggestion, I drew up a plan using part of Pathe's Stage 5, an old silent stage. Mr. Klune was made production manager for GWTW about that time. We had had quite a few production managers since Selznick International started, but only Ray Klune grasped the idea that you needed more than a script to make pictures of the quality that Mr. Selznick wanted. You needed an efficient organization and equipment to do the job. The results and time proved that he was right. With Ray's backing Jack got the okay to start a new department on Stage 5. Few people realize that Selznick International was a very small organization with very limited facilities for making the largest picture of all time. Because it was an MGM release with Clark Gable, it has been assumed by many to have been an MGM production. MGM had nothing whatsoever to do with the production.

In March of 1938 Los Angeles had a tremendous rain storm. The next day the studio had me photograph about 10,000 feet of the exceedingly beautiful cloud formations that followed the storm for background plates for GWTW. Quite a few of them were used in the production. William Cameron Menzies, who joined the Selznick organization in 1937 as production designer, had planned to use them as main title backgrounds; but that idea was later changed. I guess these cloud shots were the first production photography charged to GWTW.

In November of 1938 we started building the new matte painting department on Stage 5 and also planning for the Atlanta fire sequence which was photographed on December 10, 1938. In 1938, also, Rube Boyce became my Technicolor technician and William Neumann became an all around assistant for the department. Both Rube and Bill were almost indispensable in their help to me. Russell Hoover was added a little later on to handle the developing of our many hand tests and as an extra assistant cameraman.

Our new department was quite large, and it was planned to handle both black-and-white and color films simultaneously. It had an office for Jack Cosgrove, a

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large studio for the matte painters, and a layout-projection room for laying out the paintings in exact register for any of our photographing set-ups. This room also acted as a light trap between the art studio and the very large camera room. As we were matching the paintings with the original photography, it was necessary to open the camera magazine to remove film for hand testing and also to remove certain tests and scenes which were to be saved for use later if necessary. This had to be done in the dark so all doors into this room were locked while we were working. We had several instances on other productions, in our old department, of film being ruined by strangers walking in front of the camera or fogging the film by opening a door.

The camera room had six camera set-ups that were interchangeable for either black-and-white or color. Four of these set-ups matched exactly for image size, and of these set-ups the two that were used for color matched very closely for lighting. Therefore, it was possible to interchange set-ups should one of the camera set-ups be tied up on another painting. Our main black-and-white set-up had a B&W camera that could be used for laying out shots as well as for photography. We also had a lathe-bed camera set-up for photographing titles. Our most complicated set-up was an interchangeable B&W or Technicolor three-strip camera aerial-image optical printer. The design was an improvement over the one that I used for TOM SAWYER. It was designed by Don Musgrave, Oskar Jarosch, and me. It was easily interchangeable from the three-color camera to black-and-white in a few minutes. In front of the projector were the painting easels and light stands. The lights were the new reflector photo floods. (I had requested G.E. to blacken the bulb base of their original design to stop the stray light.) In addition, by remote control from the camera, we could do any of the following things: turn on red warning lights at all doors to the camera room; regulate the voltages on both of our main generators (this was a Vernier control for our light voltages which were regulated to plus or minus ½ volt); use either or both generators on any set-up; and run the camera, projector, or printer motors separately or in interlock from ½ picture per second to 16 fps. An electrical tachometer was at all camera positions indicating our motor speeds; also, we could control the interlock system for projection background work.

We had a large and complete dark-room for developing and enlarging, a loading room, loading dock, camera storage room, cutting room, and a generator room which had three generators for lights and an interlock generator for the camera and projector motors. Also, there were 2 miniature projectors from George Teague.

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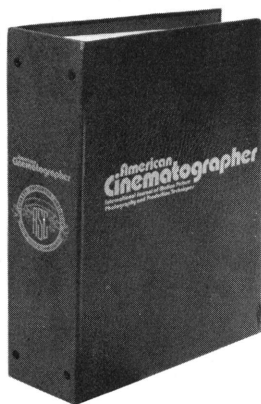
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On December 10, 1938, we photographed the Atlanta fire sequence. We used every three-color camera Technicolor had, and I also used the new and untried high-speed camera that could run at three times normal speed. We were using in the cameras, for the first time, a new film. This film was faster than the old emulsions and was sensitized so that the green and magenta filters that used to be cemented on the camera prism were no longer needed. Mr. Selznick wanted to achieve a spectacular effect on a very wide screen, for road-showing the whole fire. Jack asked me if I thought it could be done with more than one camera; I said that I believed it could be done with 2 cameras and a mirror, and that I thought that Winton Hoch, ASC, of Technicolor could do it. So part of the fire sequence was photographed with the wide screen set up using two cameras. Although the wide effect was very good when projected with two projection machines (we used two background projectors for the test), the idea was dropped before the picture was released. I also made a test of the front of the studio, using an anamorphic lens. The test was photographed in black-and-white, and the wide screen effect was satisfactory. However, Technicolor advised Mr. Selznick that it would not be feasible to use the anamorphic lens with the Technicolor process.

So, on the cold night of December 10th the cameras were in their places. The old sets from the DeMille KING OF KINGS days and other pictures were made to look like portions of Atlanta. Old cars were in front of warehouses. My high speed camera was placed around the corner of the set photographing a massive wall that had been used for KING KONG. The old sets were filled with sprinkler pipes to spray out gasoline to help the fire along. Water from storage tanks was pumped through the same pipes to hold the fire down—or to put it out. As we could not see the other cameras from our positions, we had a green light burning as a signal to start the camera and a red one to let us know when the burning wall would crash down. Lee Zavit was the expert in charge of the fire itself. I had John Hamilton and Dave Johnson from Technicolor with me and also my technician, Rube Boyce. The fire started, and from where my camera was it was going great. Then came the light to start the camera. They were having a little trouble with action or fire on the other side of the set. Also, they had forgotten that my camera was running three times normal so I was using film three times faster than they were. When our counter reached 700 feet we were beside ourselves with fear that we would run out of film, as a magazine held roughly 950 feet of film.

Seven-fifty, eight hundred, eight-fifty, nine hundred, and now the red light—the wall crashed down, and seconds later

we ran out of film—but we had the shot. Into this shot I later added the silhouettes of Rhett, Scarlett, and the horse and wagon. A most thrilling shot! We reloaded the camera, and I made many shots of the fire for backgrounds, which we used in other shots and later on for the fire sequence in REBECCA. I used almost as much film as all the other cameras combined. So GWTW was finally under way.

Our new department was shaping up nicely. We tested a new prototype background projector head that Mitchell developed. It was very quiet and had many good features, and it could work without a projection booth. The studio ordered one. While it was being built Don Musgrave, Oskar Jarosch, and Hal Corl designed and built a completely new type of base for it. It was highly mobile and easy for the projectionist to operate.

The matte painting department was nearing completion. The rooms were built and were wired and painted. Also the generators were being installed. While we were getting our department in order, all of the other departments were busy with the herculean task of getting ready for the starting date of January 26th, 1939.

Finally the big day arrived. It was a crisp, cool, sunny morning. The location was the Tara set on the back lot. Only a portion of Tara had been built. Our matte shot would be the first shot on the production. Jack Cosgrove and I made a matte in our special matte box, using our heavy line-up finder and the 35 mm lens from our camera DII. The finder was made heavy so that the tripod would not shift when the finder was replaced by the Technicolor camera. The light read left 45 degrees, 6400 ft. candles, front 7000, and right 2400; and the camera stop was set at Technicolor 8. The matte was ready, and the finder was removed. The Technicolor technician, Paul Hill, and the assistant, Al Cline, slid the Technicolor camera into the ways on the tripod head. Camera operator, Roy Clark, ran off 300 feet of film. This film would be used for making tests when the photographed scene was combined with the matte painting. As the sun and shadows change quite rapidly, another 30 feet of test film would be photographed before each take and without stopping the camera. This would give us a chance to make a final hand test and the necessary corrections for completing the matte shot. When you are working with the undeveloped original scene you are playing for keeps; any mistake will ruin the scene, and unless you have a protection take you are really in trouble. The scene was the long shot of O'Hara's home (Tara). Horses and dogs were in the driveway. Miss Leigh ran down the driveway. George Cukor was the director. Lee Garmes, ASC, was the production cameraman, and Will Cline, ASC, was from Technicolor.

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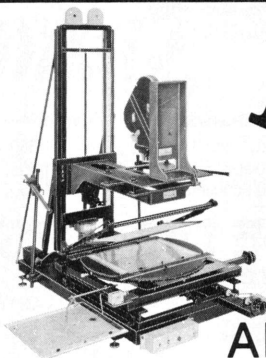
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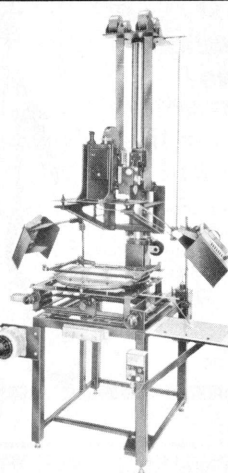


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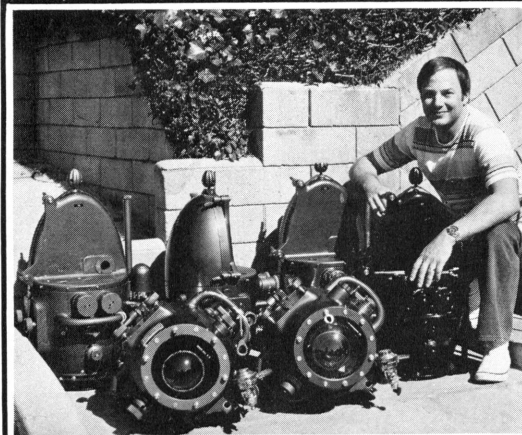
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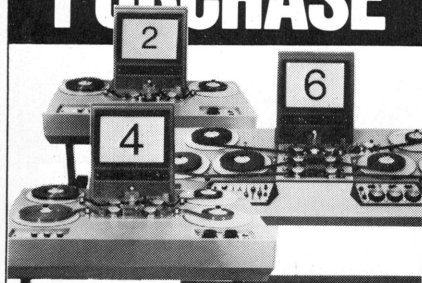
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Three takes were made. The first had NG action. Take three was the choice take. The film was notched, and another 30 feet of film was run off—both with and without the matte. It took 20 minutes to shoot the tests and the scene. My technician, Rube Boyce, took the exposed magazine back to the department, and removed the last 30 feet of film to the notch, and sent the balance of the film over to Technicolor for rewinding and reloading into another magazine. This would be returned to the matte department the next day.

In our dark room Rube developed a five foot piece from the 30 foot test film. When this was dried the film was projected in our layout room by a special projector with registration pins. This was done by Bob Cress under Al Simpson's supervision. The original shot of Tara was traced upon a 30" x 40" sheet of Masonite painted Technicolor gray. The matte line was also indicated. The next step was to draw upon the masonite the portion of Tara that had not been built. Preliminary colors and shade samples would be painted upon the masonite. When the rewind scene was returned to the department the next day, it was placed upon one of our Technicolor cameras. (We started the picture using one Technicolor camera and ended by using three.) A short test exposure was made of the drawing and color samples (on the 30" x 40" piece of Masonite). A temporary matte protected the previously photographed scene to prevent double exposure. A short hand test was exposed and developed from our exposed 300 foot test piece. The developed test negative was quickly dried, or if we were in a big rush it was analyzed while still wet by Al Simpson and me. After the many shots we had made on previous pictures, we had become quite proficient in "reading" the color match from the negatives. After working all day on the drawing and color matching by Al and Fitch we were ready to send our first matte test to the lab. This would be a piece of film about 20 ft. long. The color print, when returned to us, would be run in the projection room. The film would be looped so that we could run it as long as we wished in order to study it for any further corrections. Three lab tests were made for this scene. While the scene was ready to send to the lab as completed, it was not sent because it was decided to remake the scene with the new director.

On March 2, 1939, the production started again. The scene that we made January 26th was again the first scene to be photographed. The new director was Victor Fleming. He made few changes from the original scene. Ray Rennahan, ASC, replaced Will Cline as the Technicolor cameraman. The lens was changed to the Technicolor 25mm lens (35mm lens & R.L.) for a wider angle, and the stop was handled as described for the original scene. It was soon finished

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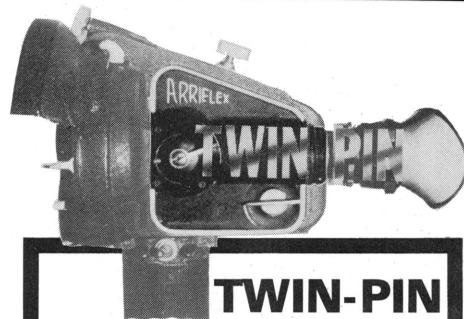
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and okayed by Mr. Selznick. Before Mr. Cukor was replaced we made several matte shots on sequences that he had directed: the Bazaar sequence and the sequence of Rhett, Scarlett, and Melanie leaving the burning Atlanta from Aunt Pittypat's house. The exteriors on this sequence were photographed by Rennahan and directed by William Cameron Menzies at night on the back lot.

This was to be our first use of combinations of original photography, matte paintings, and miniature projection. The miniature projection backgrounds were plates that I had photographed at high speed the night of our Atlanta fire. This sequence worked out very well. We also used some full-size projection shots. The sequence continued into a sequence that had been previously photographed of the Atlanta fire and climaxed with the optical composite of the silhouetted Rhett, Scarlett, wagon, and crashing wall. For the miniature projection we used a Teague projector built with a 7000 watt lamphouse on about a 30"x40" screen. Due to its intense heat, we had an automatic douser that would cut off the light if the filtered air flowing on the film dropped below a certain pressure or if the projector motor was not up to speed. The cool air also held the film in the proper focal plane.

The Technicolor film plates that we used at that time had a B&W silver key image. It was this silver image that got quite warm, and unless the film moved at a constant speed it would warp the film, giving us an unsteady and an in-and-out of focus picture. It was almost impossible to detect the warped frames by inspection on a rewind. Another nuisance was the drops of water splattering on the film, caused by the condensation in the air hose which cooled and held the film in focus. This was corrected by using an air brush filter immediately before the air hit the film. Previously the water droplets would color streak the projection key and thus ruin it. We had to be very careful of this for several reasons—cost, time lost in getting a reprint, and the fact that the reprint never matched close enough in color to tie into the color that we already had painted to. Time on GWTW was a very big factor. All of our problems had to be solved and solved quickly. Due to the fact that Jock Whitney owned controlling interest in Technicolor, our film was rushed ahead of anything else in the lab, and we received our rushes in about 24 hours instead of days. I would like to mention the excellent cooperation we received from the whole Technicolor staff—Bob Riley, Dave Johnson, Giff Chamberlain, Gerald McKenzie, and many others.

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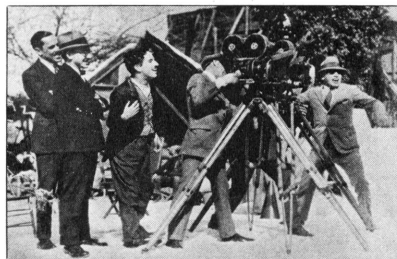
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which enabled us to move the projected image, after the projector was tied down to the floor, for slight adjustments to match the painting.

Later on, during post production, numerous other camera angles of the Atlanta fire sequence had certain effects such as smoke, falling embers, etc., added to them. At the time we made GWTW, we could not work with separation color masters nor would we have had the time. We were using a 3-strip color camera on the printer. This meant that no additional films could be run bi-pak in the camera. However, in our projector head on the printer we could run bi-pak. I had to use regular color prints or background projection prints for masters. In order to keep the contrast down, I resorted to two things: One, I would pre-fog the film in order to desaturate the color or flatten the image

This also gave a bonus of making the film about one stop faster, and also the fog could give me an overall color correction—red for fires, blue for night effects, etc. The other thing I would do was to make a film mask for the color film to reduce the highlight contrast or to slightly alter the color. This mask was made by printing onto Panchromatic negative stock in contact with the projection color film. This was done by bi-pak in a black and white camera; I then had the lab under-develop the film. This gave me very good registration. I do not know if masking had been used before in the industry, but it certainly worked for us. This mask and the film from which it was printed were then used in contact in the projector on our optical printer.

In some of the log sheets that I saved, I find that the last matte shot with Lee Garmes and Roy Clark, second camera-man, was on March 8, 1939. On March 11, 1939, Emie Haller, ASC, was now Director of Photography for the production. Ray Rennahan was the Technicolor camera-man, and Art Arling replaced Roy Clark as operator. The technician and the assistant were the same as before.

We were working at Busch Gardens in Pasadena, and the scenes to be photographed were of the news of the starting of the Civil War. Never before or since have I ever experienced the feel of realism that the making of these scenes seemed to create. This feeling carried through to the finish of the picture. Perhaps the talk of the possibility of World War II in Europe helped to enhance this feeling.

It was while we were on this location that Bill Menzies, Jack Cosgrove and I planned the pull-back shots of Scarlett and Gerald O'Hara. They were to be in silhouette against a sunset sky (a plate made after the big rain storm in 1938) with Tara (matte painting) in the background. I planned this shot to be composited on our new printer, using an aerial image of the Tara painting. It was always a joy to work with Bill Menzies. He was a man of

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great creative talent and much enthusiasm. He and Jack worked very closely together. All of Menzies' ideas were either sketched by him or by his sketch artists, Dorothea Holt Redman, J. McMillan Johnson, and Howard Richman. When one of his ideas was okayed by Mr. Selznick we would plan on the best way to put it on film. We also worked very closely with Lyle Wheeler in achieving his ideas for the sets. After we photographed a matte shot we would send an 11x14 enlargement of the matted scene to Lyle. He would have one of his men draw upon this print what he wanted in the completed shot. From this working sketch-photograph our matte artists would then paint the matte shot.

We also worked very closely with film editors Hal Kern and James Newcom. Whenever possible Jack would run all the shots or tests with them and Mr. Selznick for whatever changes they might wish. Both Hal and Jim were very helpful and always available for advice when needed.

Shortly after our Busch Gardens' location, some added scenes were photographed for the Bazaar sequence. Plates for background projection also were photographed of the dancers. These plates were used for Rhett and Scarlett dancing. They were photographed from a special camera mount designed by Don Musgrave. This mount could swing or rotate the large Technicolor camera on the axis of the lens. It also could swing the camera on the photographic axis for a few degrees or in a complete revolution and at any point up to about a four foot radius. The camera was counter-balanced and very easy to handle. With this set-up the camera could dolly and swing in tempo with the dancers.

Things had been progressing quite smoothly when we ran into a tough shot unexpectedly. It was a classic example of one of the problems sometimes encountered while matting on original photography. A set had been built on the exterior of stage II. The scene was the arrival of guests and carriages at the porch of Twelve Oaks mansion. It was photographed by Garmes and Rennahan, with Fleming as the director, on March 8th. Our main test was photographed at 3:45 p.m. in crosslight and the selected take at about 4:15. There were fluted columns in the set.

There are several things that have to be watched carefully when matting on original photography. The width of your matte blend is controlled by the focal length of the lens, the camera stop, and the distance between the lens and the matte. As you stop your lens down the matte becomes sharper and pulls into the picture, so you have to watch for people's heads being cut off and also the danger of over shooting into the unfinished portion of the set. In the case of this shot it was unavoidable that the matte had to be placed across the fluting on the

columns in the set. Jack was an old hand in the making of mattes, but here was one that offered no easy way out. As we started working on the shot, we noticed that the fluting on the columns did not match our painted columns from test to test, due to the shadows changing, and also as the sun was getting lower into our Culver City haze the color was changing on the columns. There was no better artist than Al Simpson for matching a matte shot, yet from my log sheets I find that it took 46 hand tests and 3 lab tests and 27 feet into our final test before we could match the scene. The finished scene was fine, but it sure put a monkey wrench into the department while we were working on it.

On the 28th of March we started the Atlanta Railway Station sequence with the arrival of the wounded soldiers. Our first matte shot was to be the exterior with a carload of wounded pulling into the station. Only a portion of the railroad station was built, enough to cover the action. The rest of the set was to be completed by making a matte painting. On the left side of the set was a partially constructed locomotive. It was our job to complete the station and the locomotive. This would have been a very simple shot except that they wished to have black smoke pouring from the painted smoke stack. In B&W this shot would not have offered any problems, but with the 3 color camera it was impossible. With one exception: it could be done by using our new optical printer. This was to be the first real test of our aerial image set-up. I had proven to myself, by a simple shot on TOM SAWYER that such a shot could be possible. So, we stuck our necks out and said that we could do it. Our matte procedure on the set was a normal one. However, when we put the shot together in the department things were quite different. The 3 color camera, with exposed scene, was placed on the camera carriage of the printer. In the projector head was placed a print of black smoke on clear film. (I had photographed some black chimney smoke in the proper line-up for this shot.) Our aerial image lens was one of our background projection lenses. I had found that camera lenses were not suitable for an aerial image. I needed a lens in which all of the elements were the same size, which had excellent contrast, fast speed, and was large enough in diameter to permit panning across the film to the right or left or tilting up and down. The focal length should be about 125 mm. By luck I had a Carl Zeiss lens of 13 cm focal length which proved to be ideal. The painting was picked up as an aerial image and erected in the printer in focus and on the same focal plane as our smoke film. The black smoke would then hold back the portion of the painting over which it passed. So now we had a completed railway station and an engine with black smoke coming out of its smoke stack. This way of working was

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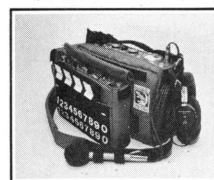
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so satisfactory that I made it my principal method of working for the next 30 years. It was demonstrated to the students of the USC Cinema division many times at MGM Studio's matte painting department.

A short time after the railway station matte shot, Victor Fleming became ill. He was replaced by Sam Wood and William Menzies. During this period we made quite a few matte shots with both directors. On many of the matte paintings we added, by miniature projection, fire and explosions.

In a couple of weeks Vic Fleming returned to work. We now had three units working. Bill Menzies had these sequences so well laid out that when the scenes were cut together there were no differences in visual effects or continuity between them. Fleming resumed shooting in the Atlanta Railway station with the wounded soldiers. We made numerous matte shots here, and light rays for pictorial effects were added to many of the scenes.

It was here that the now famous scene was made of Scarlett walking among the wounded, with the camera pulling back and up high into the air. The shot was made from a construction crane, and was photographed by the production company. We also made a matte shot from a high parallel. It was an extreme long shot showing the station with hundreds of wounded soldiers lying on the ground. The studio used all of the extras that the Guild could supply for wounded soldiers, about 1500 of them, and added about 1000 dummies. We painted in more soldiers in the blank spots of our matte shot.

When our shot was finished at 11:30, the assistant directors called "lunch." It was like God had passed his healing hand over the wounded, for 1500 soldiers leaped to their feet and ran for the lunch wagons.

The sequence of the evacuation of Atlanta was the most thrilling motion picture sequence I have ever worked on. Again there was that feeling of actuality: with people running, explosions, fire, smoke, the red dust of Georgia, and horses and wagons trying to thread their way between retreating soldiers and wounded men.

We decided to use split-screens, if possible, to make the exterior street scenes outside the Examiner newspaper office of the tense silent crowds waiting for news of the battle of Gettysburg. There were two angles of the large crowds to be photographed. If we could use split-screens we could double the number of people. While we had had a great deal of success with split-screens in B&W for THE PRISONER OF ZENDA, it was still untried for three-color Technicolor. I had previously used paper mattes cut to the desired shape and held in position on a framed piece of glass. This framed glass was held in position in front of the camera by a heavy duty tri-



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pod. As these shots were to be made out of doors, it would be necessary to work as fast as possible, due to changing light and shadows. First, though, it would be necessary to establish a blend width and a camera lens stop. By a hand test I found it possible to make split-screens with the 3-color camera. As the three film loops in the Technicolor camera were quite complex, we were not sure that they would hold their positions while we were running the camera backwards, for it would be necessary to rewind at the speed of 24 between exposures. (We would not have time to change to a variable speed motor for rewinding.) It was decided not to ask Technicolor's permission to do so, for we had been rewinding at the speed of 16 in the department without any trouble. The Technicolor camera was a beautifully designed and built camera, and it proved to be very rugged and flicker free. In all of the great many shots that I made with this camera, never once did it let me down.

The day before we made the shots, I had Nelson Cordes, my Technicolor technician, set up the tripods on the desired angles that Bill Menzies and Jack Cosgrove had selected. Using our line-up finder and the Technicolor lens set at the stop which we thought that we could work at, I cut the mattes. The tripods were tied down in those positions. Then we replaced the finder with the camera and made a short test which I had developed. The test was okay. We indicated on the set where each half of the split would be so that it would be easy and quick for the assistant directors to replace the people between halves. The next day we quickly made the shots with our previously cut mattes and at the estimated camera stop. We found that by the time we rewound the camera the assistant directors had placed the extras in their second positions. Everything went smoothly, and both shots were very successful. Ray Rennahan was the Technicolor cameraman.

We made many more matte shots than I have mentioned here. I have tried to describe the way the shots were made and some of the problems encountered. As in all large pictures with lots of production, there are shots that you would like to change after you have seen them cut into the picture. The fact that you have a release date prohibits many changes.

For example, a scene was needed of a river boat on the Mississippi. It was decided to make this scene part miniature and part matte painting. This shot looked very unreal. I suggested to Jack that if James A. Fitzpatrick (of travelogue fame) was available that Mr. Selnick send him to Mississippi to photograph a real steamboat. That was done, and Fitzpatrick went to Natchez, Mississippi, with Will Cline as cameraman and Bob Carney and Howard Nelson as assistants. The steamboat shots were beautiful. While they were in Natchez they also photographed some cotton pickers for us to be

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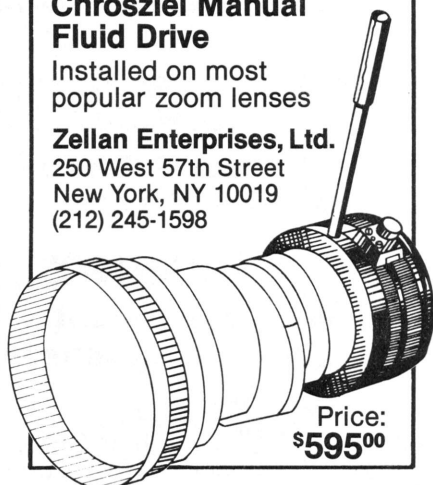
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completed as a matte painting.

Around one hundred matte shots were made for the picture. In addition, we did numerous photographic effects and other work. For our matte shots, we worked almost entirely with the original undeveloped negatives of the action. With the 3-color Technicolor camera, the IB prints, and the small projection screens of those days, it was not as necessary for the artist to paint the scenes as meticulously or as sharp as is required today. The use of high definition film with sharp lenses requires much more painting detail today for the wide screen. I have seen GWTW twice since its original release, once using Mr. Selznick's personal Technicolor print when Mr. Selznick and I ran the picture for Vittorio De Sica. Much later when the picture was going to be released on 65mm film by MGM, George Davis, Mac Johnson, and I ran a 1.85 ratio print. Each time it was noticeable how amazingly beautiful the photography was with the three color camera.

In retrospect I cannot help but wonder at the marvelous production crews that were assembled for GWTW, INTERMEZZO and REBECCA. I have to include the last two pictures for we were working on all three pictures simultaneously. On all large pictures there is a certain amount of confusion, but the production office, under Ray Klune, managed to keep things running quite smoothly. Of course, we were all very tired—including Mr. Selznick who personally checked on all phases of production.

We knew we were making some excellent pictures, and felt that Selznick-International would be one of the outstanding and growing production companies in the industry, and that all of us would benefit from it. However, that was not to be, for when the war started in Europe those who were heavily invested in Selznick-International and its productions were anxious to take their profits and dissolve the company. So by Christmas most of this wonderful production team was gone. I have mentioned the names in this article of some of the persons closely associated with me. There were many more, and I wish that I could remember their names and had the space to write about them.

When a comparatively small special effects department can turn out as many matte and other effects shots as we did, you know that we had many loyal and competent people cooperating with us when we really needed help.

Jack Cosgrove is no longer here to speak for himself, so let me say I know of no other person working closely with Bill Menzies who could have seen the opportunities for the use of so many mattes or composite shots. I have deep appreciation of Al Simpson, Fitch Fulton, and Jack Shaw, our matte artists; and, of course, my very loyal photographic crew, both at the studio and at Technicolor.

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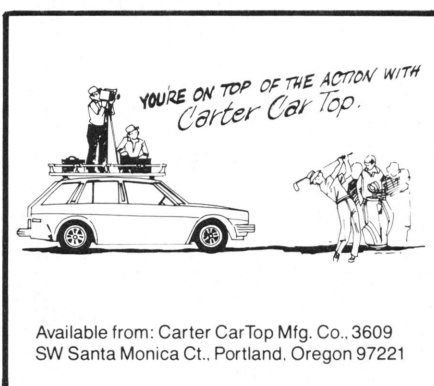
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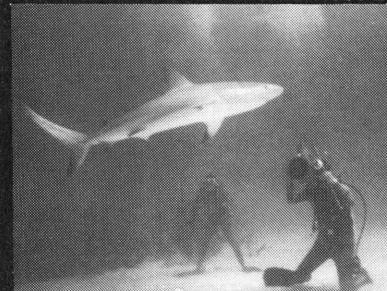
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On June 27, 1939, the principal photography of GWTW was finished. Many of us received in the studio mail a facsimile of a studio script cover, on which was printed:

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GONE WITH THE WIND

CALL SHEET

June 27, 1939.

Inside was a single page with:
"In gratitude for your unfailing efforts and courtesy during the long siege of Atlanta and in celebration of the conclusion of the damn thing, we request the pleasure of your company at a little party to be given on Stage 5 immediately after Tuesday's shooting June 27th.

Vivien Leigh

Scarlett

Olivia De Havilland

Melanie

Clark Gable

Rhett

Leslie Howard

Ashley

Victor Fleming

Big Sam

David O. Selznick

Jonas Wilkerson"

The party was held on the same stage our department was in, so we only had to walk out of one of our doors into the party; and when the party was over, open our department door and go back to work.

The day we photographed the main title card "Gone With The Wind" the war in Europe had started only a few hours before. We first found out about it from the New York office's teletype to the studio. The GWTW title was quite large so the camera was mounted on a camera dolly that was mechanized so that we could move across it smoothly at various speeds. Mr. Selznick had requested that the dolly across the title move fast and with as little strobing effect as possible. Fred Williams, the company grip, was handling the dolly. He mounted a radio near by so that we could listen to the latest war bulletins as they came in. We all wondered how soon the United States would be involved. In this atmosphere the anxieties of the Civil War seemed a little closer to us that day. Little did Fred Williams know he would be one of the cameramen photographing the Invasion of Normandie a little later on. Nor did we know that the war would be one of the leading reasons for the early demise of Selznick-International.

After the sneak previews of GWTW it was decided to have an intermission during the picture. The picture would start again with a montage of Sherman's march through Georgia. The montage

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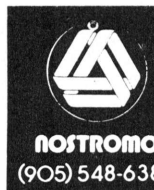
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was conceived by Peter Ballbush. I have forgotten the exact contents of the montage, but it did have soldiers marching, men running, cannons, caissons, and cavalry rushing by and pouring from a swirling cone of Georgia red dust, flames and then dissolving into a cotton patch.

The dust cone was created by a whirlpool of paint in water. The soldiers, cavalry, etc., were photographed both in color and in B&W. We used this B&W version in the montage, as the silhouetted men that I had photographed on matte positive film gave us the best effect. The final print of GWTW for the premiere in Atlanta was being printed at Technicolor, and they were almost ready to print the reel that would contain the montage. There was so little time left to make the montage that it was necessary to do it on our optical printer with the Technicolor camera. The Technicolor camera did not have a dissolving shutter. Simple fadeouts could be made with a device that attached to the camera lens. As I was using the camera lens stop for light balance between scenes, we could not use that method. We were fortunate to find another satisfactory way of making lap dissolves, using an iris to control the light from a lamp-house through our aerial image lens. Now we were ready to start work on the montage. Time was growing extremely short. The date of the premiere in Atlanta, Georgia, had been set for December 15, 1939, and it was almost the middle of November, with a lot of work yet to be done by others after we finished.

So, early one morning, with the help of Bert Willis, Russell Hoover, and Bill Neumann, we started. About twenty-six hours later we finished, tired and bleary-eyed and hoping that this would be the last of GWTW, as far as we were concerned. Shortly after I had returned home and just fallen asleep, my phone rang, and it was Bob Riley of Technicolor. He said that he had bad news. There was a hair in the aperture in the last scene. This could only mean disaster. We were so tired I could not see how we could possibly remake the montage again very soon. What could be done? Had Bob said the last scene? That was right, so I asked him, inasmuch as the cotton patch scene was a straight production scene, would it be possible for Technicolor to replace our bad scene with the original during the dissolve from the effect scenes. He said he thought so, and he would have the lab try it. When I returned to the studio I had a call from Bob telling me not to worry for the montage was okay made that way.

So, on November 17, 1939, GONE WITH THE WIND was finished for me.

I am glad to have had the opportunity to work on the production of GONE WITH THE WIND. It was a "once in your lifetime picture." Jack Cosgrove and I, when we read the galley proof of GWTW almost three years before the production started, never doubted but that Mr. Selznick had one of the greatest pictures to make. ■

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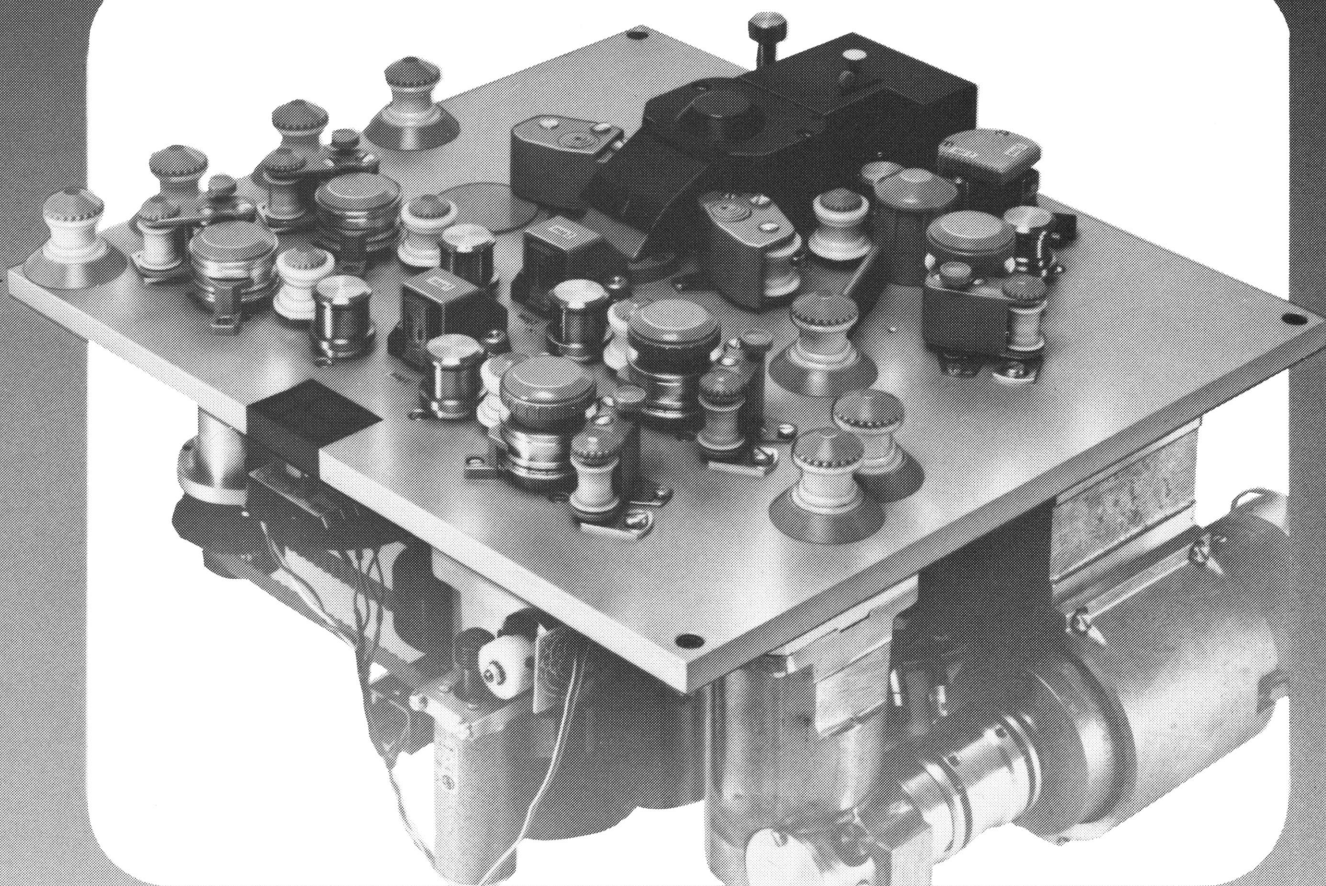
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